LIBRARY
FISH & WILDLIFE SERVICE
PACIFIC OCEANIC FISHERY
INVESTIGATIONS

CONSEIL PERMANENT INTERNATIONAL
POUR L'EXPLORATION DE LA MER
34B STRANDVEJ, HELLERUP – DANEMARK

JOURNAL DU CONSEIL

VOL. XI · NO. 1

PUBLIÉ PAR LE BUREAU DU CONSEIL

RÉDIGÉ PAR

E. S. RUSSELL

EN COMMISSION CHEZ
ANDR. FRED. HØST & FILS
COPENHAGUE

AVRIL 1936

Note.

The Journal of the Council will in future appear *three times a year*, and three numbers will form a volume. It will include, in addition to general articles, reviews and bibliography, the special papers hitherto issued in the series of "Publications de Circonstance".

The annual subscription price has been fixed at 12 Kroner (+ Kr. 1.50 for mailing expenses) per volume, which will include, if desired, a reprint of the bibliographical matter, printed on one side of the paper. Single copies will be sold at Kr. 4.50.

Contributions to the Journal should be addressed to: —

The Secretary
Journal du Conseil,
Fisheries Laboratory,
LOWESTOFT, England.

They may be written in English, French, German or Spanish. General and scientific articles must be accompanied by a summary. General articles and reviews, asked for by the Editor, will be paid for at the rate of 10 Kroner a page. The payment for a general article shall not exceed Kr. 200. No payment is made for other articles. Authors of general articles and scientific papers will receive 50 copies of their paper gratis. Typescripts and figures should be submitted in a state fully prepared for press, in order that the costs of proof correction may be reduced to a minimum, and no expense be incurred by the Council in re-drawing any figures. Reviews should not exceed 600 words (one page). *Contributors are requested to follow the instructions printed at the end of the number.*

Correspondence, as well as books and papers for review or bibliographical notice, should be addressed to the Secretary.

Orders for copies should be sent to Messrs. Andr. Fred. Høst & Søn, Bredgade, Copenhagen.

CONSEIL PERMANENT INTERNATIONAL
POUR L'EXPLORATION DE LA MER
34B STRANDVEJ, HELLERUP – DANEMARK

JOURNAL DU CONSEIL

VOL. XI · NO. 1

PUBLIÉ PAR LE BUREAU DU CONSEIL

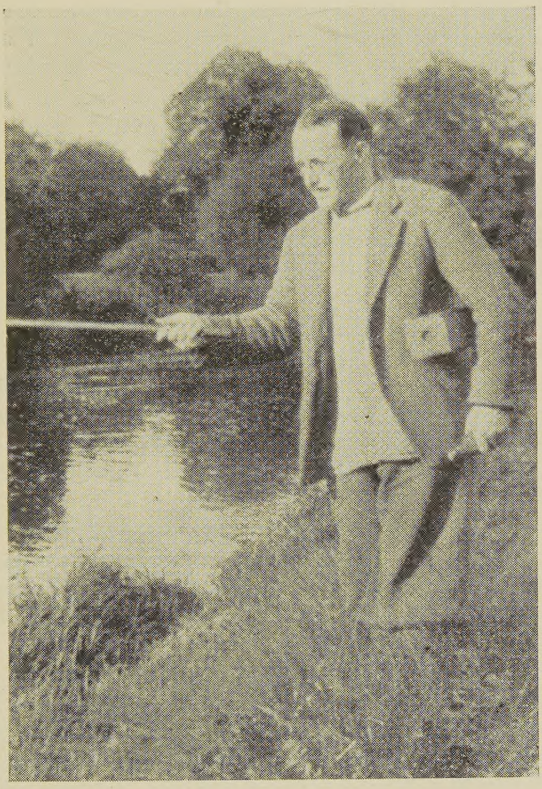
RÉDIGÉ PAR

E. S. RUSSELL

EN COMMISSION CHEZ
ANDR. FRED. HØST & FILS
COPENHAGUE

AVRIL 1936

A/S L. IHRICH - COPENHAGEN



Rowland Southern.

(1882—1935).

IT is difficult to realize that Rowland Southern is no longer with us. He was so full of life, so young in his ways, and enjoyed so tremendously his work, his fishing, and his many outdoor activities. At the time of his death in Dublin, on December 13th, 1935, he was only 53 years of age.

Nearly all his working life was spent in Ireland. In 1902 he was appointed Assistant to the City Analyst in Dublin, but in 1906, realizing that his main interest was biology, he secured a post in the Natural History Section of the Irish National Museum. From this he transferred, in 1911, to the Fisheries Branch of the Department of Agriculture and Technical Instruction and was one of the band of naturalists who, led by the late E. W. L. Holt, added so much to our knowledge of the fauna of the Irish coasts. Up to the outbreak of the war his interest centred chiefly on a systematic study of Annelid and other worms. His publications during this period amount to some seventeen papers, including six dealing with the fauna of Clare Island, in the survey of which he took an active part.

Rejected for active service, he was given, in 1917, the task of investigating the possibilities of the greater use of freshwater fish as food. This work took him to Lough Derg, where later there was established the Limnological Laboratory of which he was placed in charge, and from then until the time of his death his chief interest was the biology of fresh water.

Southern was a born systematist and when the lack of a botanist at the Limnological Laboratory compelled him to take up the study of the freshwater algae he familiarized himself with this large and difficult group with surprising rapidity.

When the Limnological Laboratory was closed down in 1923, Southern returned to Dublin and devoted himself to a close study of the salmon and trout fisheries of the Irish Free State, and the "*Angler's Guide*" to that country, with its mass of accurate information, was almost entirely his work. It was his intention to embody his many observations on the life history of the trout in book form and he was happily engaged on this in his spare time when death overtook him.

His gay smile and almost boyish manner and his keen enjoyment of sport covered a critical and painstaking scientific outlook, a fact not immediately appreciated by the casual acquaintance. Although a master of detail both in the laboratory and in the field, he was forever filled with "horrid doubts" that some small point had been overlooked and that perfection had not been attained. The exacting technique of nanno-plankton enumerations was performed with meticulous accuracy and methods were exhaustively tested before

adoption. That he was able to complete a series of weekly nanno-plankton "counts" from the River Shannon over a period of fifteen months, in addition to those from three other lakes, is a tribute to his pertinacity. His favourite and oft-repeated slogan at that time was: "A bug in the Log is worth ten in the bottle".

Work over, he would rush tumultuously from the laboratory shounting "Come on, let's catch a fish", and until the light failed would angle with equal zest for trout, minnows, rudd, pike, or even the very young fry, which he needed for experimental purposes. He was always cheerful and although apt to worry unduly over some trivial matter was rarely seriously put out. From a sudden immersion in the Shannon in mid-winter he emerged clutching his fishing rod, the picture of beaming good humour, and at the most mildly regretful for the loss of time occasioned by lighting a fire before which to dry his clothes.

He was a skilled dry-fly fisherman and although delighting in stalking and landing a good fish, he invariably measured and weighed it, took scales, and examined the stomach contents. On reaching a new locality his first action would be the determination of the hydrogen-ion concentration of the water and latterly a set of the necessary standards was always in his car. With the pH was systematically correlated the size of trout, the abundance of fish food, and the presence or absence of certain aquatic flies, and there is scarcely a river or lake of importance in the Irish Free State for which he had not these data. Observations stretching over many years, coupled with his extensive investigations on the River Liffey, led him to the belief that the difference in size of trout in acid and limestone waters is not due, as is generally alleged, to the greater abundance of food in the latter.

There are many friends and colleagues, who have known or worked with S o u t h e r n for far more years than the writer, who nevertheless can count it one of the most fortunate circumstances that he shared with him for three years the cramped living-room of the houseboat *Changsha,* which was the official headquarters of the Limnological Laboratory. During that tragic period when Ireland was distracted by civil war and when access by road or rail to even the nearest town was difficult and dangerous S o u t h e r n's optimism and courage never wavered. His capacity to extract the utmost pleasure from his work and the gift which he possessed so abundantly of communicating this to others made him an

ideal companion. It was impossible not to appreciate the critical mind, the broad, kindly outlook and the intense love he had for his adopted country. At all times in the years that followed he was ever ready with helpful criticism and advice and with his death we have lost a true friend and wise counsellor, whose presence inspired fresh conceptions and stimulated anew the spirit of enquiry.

A. C. G.

The Philosophic Basis of Statistical Analysis.

By

H. J. Buchanan-Wollaston,
Fisheries Laboratory, Lowestoft.

The Method of Least Squares (continued).

By making a the mean of the Y's, and measuring the Y's from this mean we have

$$S(Y) = 0$$

and need not solve for a, the equation becoming

$$b\,x = Y$$

and we have $S(b\,x - Y)^2 =$ a minimum,

$$S\,x\,(b\,x - Y) = 0 \qquad b\,S(x^2) = S(x\,Y)$$

$$b = \frac{S(x\,Y)}{S(x^2)},$$

the equation for finding the linear regression coefficient b.

The ordinary calculation of the arithmetic mean conforms to the method of Least Squares. If the mean be m, and n is the number of observations y we have

$$S(m - y)^2 = \text{a minimum} \qquad \frac{\partial}{\partial m} S\,(m - y)^2 = 0$$

$$S\,(m - y) = 0 \qquad S\,m = S(y)$$

$$n\,m = S(y) \qquad m = \frac{S(y)}{n}$$

The arithmetic mean therefore is the number about which the observations have the lowest possible variance.

"Normalizing" a Sample.

Some of the most important statistical tests are valid only if the sample of numbers to which they are applied may be regarded as a "normal sample". The tests are *useful* even when applied to non-normal data, but allowance has to be made for their non-normality

and it is not always possible to estimate the character or extent of this allowance. It is always preferable to bring the sample as nearly as possible to normal form before applying the tests.

In general, there are two ways in which a sample may be normalized without interfering with the implications inherent in statistical testing. The first belongs more properly to the methods combined under the technique of the Analysis of Variance and will be dealt with later. The second consists in replacing each number in the sample by some function of it — the same function, of course, for each number.

We may be guided, sometimes, in our choice of the form of the required function by considering what effect on the total variation of our numbers would occur if these were split up into groups and the variation calculated about the means of the groups. It is only a particular kind of splitting up which is being considered at the moment. We can find as a rule another continuous variate which is correlated with the sampled variate throughout the range of both. For instance, length of leg is correlated with total height of human beings throughout the range of heights. We are interested in seeing whether the variation in total height among individuals all having the same leg-length is constant for all leg-lengths, or whether it is related in a simple way to the mean heights corresponding to different leg-lengths. If it is found that variation about mean height is proportional to mean height, the substitution of the logarithms of the heights for the heights themselves will have a "normalizing" effect on the whole distribution of heights. If variation is proportional to the square root of the mean height, the square roots of the heights should be substituted for the heights themselves. The general rule is that we substitute the function

$$\int \frac{1}{f(x)}\, dx$$

for x, where x is any observation and "f" is the function of the means to which the variation about the means is proportional.

Large or Small Samples?

Each numerical observation may be regarded as a definite amount of information about the parameters of the frequency distribution to which it belongs. All observations are of equal value provided that they are random and equally precisely carried out. It is clear therefore that $2n$ observations give exactly twice as much relevant information as n observations. Statistical methods cannot add information to that inherent in the observation. It is clear therefore that large samples are vastly superior to small for all statistical enquiries into natural phenomena.

In many cases the taking of a great mass of observations is impossible. This applies particularly to experimental work. The older

schools of statisticians considered that small samples were almost useless, forgetting that every sample contains information which it is the statistician's business to extract. The statistician must find out what the sample indicates, though the indication may be negative in character. For instance, moderate deviations from the normal distribution cannot be shown in small samples, while quite slight deviations of this kind show up in large samples. Statistical theory used to be applied quite wrongly to small samples. It is due to the researches of "Student", Fisher, and others, that small samples can now be treated statistically just as correctly as large samples. The beauty of the *t*-test and the *z*-test lies in this fact. Their results are at least as correct with small samples as the ordinary tests of difference between means or standard deviations in large samples, and thus such tests are rendered universally applicable. The newer theory cannot, however, extract more information than is inherent in the sample and no possible statistical theory can ever affect the fact that the amount of this information is exactly proportional to the size of the sample, if all the observations are random observations of the *same* population of numbers.

Sometimes a collection of small samples is more valuable than one large which is an aggregate of the small. This is only possible, however, when there are significant differences between the small samples. In this case lumping the samples together into one obscures the differences between them and information is lost.

Special Applications of Statistical Theory to Observations.

One of the simplest instances of the application of the theory of chance to the study of numerical data is in the enquiry whether a particular distribution in space is uniform in the statistical sense. By such uniformity exactly equal spacing out of the objects studied is not meant. Statistical uniformity implies only that each object is equally likely to be in any part of the space in question. For instance, if there are twenty copepods in a small body of water and we consider this to be divided into twenty equal parts, uniform distribution implies that the chance of any particular copepod's being in any twentieth is exactly equal to that applying to any other particular copepod. This chance is one-twentieth for each copepod. The chance of two copepods being in any twentieth is $\frac{1}{20} \times \frac{1}{20}$ or $\left(\frac{1}{20}\right)^2$ and so on. There is always the chance of a "statistical cluster" of copepods; indeed, if observations are continued indefinitely, it is certain that fairly large clusters will be observed now and then. It is necessary therefore to have some criterion by which to judge whether observed variations in occurence of organisms in space may be reasonably ascribed to chance or whether they should be regarded as due to biological or other causes.

The Binomial and the Poisson Distributions.

Let us assume that a mass of water contains 20 copepods and that the catching instrument we use for taking samples is error-free and samples one-twentieth of the water mass. The chance of taking any particular copepod in a haul is $\frac{1}{20}$ and of not taking it, $\frac{19}{20}$. The chance of taking no copepods at all is clearly $\left(\frac{19}{20}\right)^{20}$. There are, however, twenty ways in which one copepod may be taken and the others left, the chance of any *one* way, that is to say the chance of taking one *particular* copepod and not taking all the others, being clearly $\left(\frac{1}{20}\right)^1\left(\frac{19}{20}\right)^{19}$. The total number of ways of taking one and leaving all the others is thus $20\left(\frac{1}{20}\right)^1\left(\frac{19}{20}\right)^{19}$. By the same reasoning it may be shown easily that the chances of taking 0, 1, 2, 3, 4, etc. copepods in a sample are given by the successive terms in the expansion of the binomial $\left(\frac{19}{20}+\frac{1}{20}\right)^{20}$. Suppose now that the number of copepods in the water mass is doubled. Each *particular* copepod still has the chance of capture $\frac{1}{20}$. Thus the chance of capture of two *particular* copepods together is $\left(\frac{1}{20}\right)^2$, and of capturing every copepod $\left(\frac{1}{20}\right)^{40}$. The chances of taking 0, 1, 2, 3, 4, etc., copepods in one haul are now given by the terms in the expansion of

$$\left(\frac{19}{20}+\frac{1}{20}\right)^{40}$$

which we may write

$$\left(\frac{19}{20}+\frac{1}{20}\right)^{20\times 2}$$

The mean of this binomial, that is to say the mean number captured in a haul, is given by

$$\frac{1}{20}\times 40 \text{ or } 2,$$

which is, of course, in accordance with common sense.

We may write any binomial of a similar kind to those given, thus

$$\left(\frac{n-1}{n}+\frac{1}{n}\right)^{nm}$$

where m is the mean density of organisms per haul, and $\frac{1}{n}$ is the proportion of the water mass in question which is sampled by the instrument of capture.

There is no necessity for m to be a whole number or greater than unity. It must be positive, since a negative binomial distribution indicates that the space distribution being examined is *not* uniform.

Expanding

$$\left(\frac{n-1}{n}+\frac{1}{n}\right)^{nm}$$

we have

$$\left(\frac{n-1}{n}\right)^{nm}+nm\left(\frac{n-1}{n}\right)^{nm-1}\left(\frac{1}{n}\right)+\frac{(nm)(nm-1)}{2!}\frac{(n-1)^{nm-2}}{n}\left(\frac{1}{n}\right)^{2} \text{ etc.}$$

If now the water mass is very large compared to the quantity sampled in a haul, the chance $\frac{1}{n}$ may be considered to be infinitesimal, n therefore being an infinity of the first order. It must be remembered that $\frac{1}{n}$ is the chance of taking any *particular individual* organism, not the chance of taking any undesignated organism of the same kind.

We have, now, for the binomial expansion

$$\left(\frac{n}{n}\right)^{n\cdot n}+\frac{nm}{n}\left(\frac{n}{n}\right)^{n\cdot n-1}+\frac{(nm)^2-nm}{2!\,n^2}\left(\frac{n}{n}\right)^{nm-2} \text{ etc.}$$

$$\text{or } 1+m+\frac{m^2}{2!}+\ldots\ldots\ldots$$

which are the terms in the expansion of e^m. The sum of these terms is not unity, and all theoretical distributions must sum up to unity. Thus we write for the distribution of 0, 1, 2, 3, etc, copepods per haul

$$e^{-m}\left(1, m, \frac{m^2}{2!} \ldots\ldots\right) \text{ or } e^{-m}\left(\frac{m^x}{x!}\right).$$

the Poisson Series with mean m, x being any number of copepods, and $e^{-m}\left(\frac{m^x}{x!}\right)$ the proportional frequency of this number in any set of hauls. The standard deviation of any binomial $(q+p)^n$ is $\sqrt{npq}$. Thus the standard deviation of

$$\left(\frac{n-1}{n}+\frac{1}{n}\right)^{nm}$$

is $\sqrt{\frac{nm\,(n-1)}{n^2}}$ or $\sqrt{m}$, when n is infinite.

The variance of a set of numbers distributed in the Poisson distribution is therefore equal to the mean number. The mean, therefore, is completely descriptive of the Poisson series to which it applies. This fact is of great importance in statistical theory.

Before passing on to the appropriate tests for uniformity of distribution it will be of interest to compare the terms of a Poisson series with the corresponding terms of the corresponding binomial in which n is by no means infinite.

These are given in Table 1 for the Poisson of mean 4 and the binomial $\left(\frac{19}{20}+\frac{1}{20}\right)^{20\times 4}$

Table 1.

x	Binomial	Poisson
0	.01652	.018316
1	.06954	.073263
2	.14457	.146525
3	.19783	.195367
4	.20043	.195367
5	.16034	.156293
6	.10550	.104196
7	.05869	.059540
8	.02819	.029770
9	.01187	.013231
10	.00444	.005292
> 10	.00208	.002870
	1.00000	1.000000

It will be seen that the discrepancy in any frequency is never as much as one per cent. of the total, though the sample forms quite an appreciable proportion of the sampled space. This should be an answer to anyone who doubts the reasonableness of using the Poisson in place of the binomial in appropriate cases.

An interesting feature of the Poisson distribution is that the sum of two numbers distributed thus with means m and n respectively is distributed in the Poisson with mean $m + n$. Thus, if we have a copepod distribution of mean density per haul equal to 8, and another with mean equal to 10, the numbers of both together will be distributed in the Poisson with mean 18. This rule applies to the sum of any number of numbers distributed thus. It applies therefore to the total number of objects taken in any number of samples. Thus if 100 copepods are taken in 20 samples, the total is distributed in the Poisson Series

$$e^{-100}\left(\frac{100^x}{x!}\right)$$

The standard deviation is $\sqrt{m}$ or 10, and this supplies a criterion for testing the significance of a difference between the total catch of one set of hauls and another. This test should not be applied unless the total is fairly large, say at least 25, since the Poisson distribution is skew when m is small. If m is small it is preferable to look up the proportional occurrence of *each* of the observed totals when the true total is assumed to be the mean of these. A table of proportional frequencies of use in such a test is given in (2)[1]. When m is large, the distribution may be assumed to be normal for testing purposes.

The Poisson distribution applies also to objects regarded as grouped according to their size, weight, or other measurable character, provided that distribution in space of the objects in each size-group is uniform over the space investigated. Statistical uniformity is meant. It is necessary that the presence of any one of the objects considered in a

[1]) See Bibliography.

small part of the space does not appreciably affect the chance of the presence of any other one of the objects. For instance, fish in the sea are certainly affected by the shoaling instinct and by the presence of shoals or patches of food organisms. It can hardly be expected therefore that the numbers in each size-group taken in random samples should be distributed in Poisson series. If, however, in each shoal, the fish are uniformly distributed in space, and successive trawl hauls sample the same series of shoals, the total numbers caught in a series of hauls of equal duration would conform approximately to a Poisson series, as would also the numbers in each size-group, were it not for variability in the catching power of a trawl. The fact that the trawl catches only a proportion of the fish on the ground over which it passes does not affect the case provided that this proportion, applicable to any size-group, does not vary from haul to haul. There is little doubt, however, that the proportions caught vary from haul to haul, and that, because of this, the variability in numbers caught is greater than that applying to the Poisson series. This circumstance affects the application of statistical tests for significant difference between the catches of different nets, and for significant differences in catches on different grounds and in different seasons. When applying such tests this additional variability should be allowed for by considering a difference significant only when it is extremely unlikely to arise by chance.

Variability in catching power is no doubt very appreciable in the case of all nets, including tow-nets, but probably inappreciable in the case of water bottles or pump and hose as used for plankton collection.

Testing for the Poisson distribution. The χ^2-Test.

It is not generally necessary to test the *fit* of a group of "counts", such as numbers of a planktonic organism, to the Poisson series. Usually it is sufficient merely to test the variability of the numbers about their mean. Except in the case of experiments in random sampling with known chances of occurrence, the mean of the best-fitting Poisson distribution is assumed to be the mean of the counts examined. Thus variation about the mean loses one degree of freedom. If x is any count and $\bar{x}$ the calculated mean, we calculate

$$S \frac{x - \bar{x}}{\bar{x}}$$

which is distributed as is χ^2 for n, the degrees of freedom, one less than the total number of counts. The use of the χ^2 table is described fully in Fisher (**1**), and it is not necessary to discuss here the normal use of the test. If many values of χ^2 can be obtained so much the better, since the test of agreement of an observed χ^2-*distribution* with the expected distribution is clearly much more decisive than the mere examination of the position of one value of χ^2 in that distribution.

When using variability of numbers about a mean as a criterion of the hypothesis of the Poisson distribution it should be remembered that

too small variability is just as much an indication of the unlikelihood of the hypothesis as is too great variability. If the observed value of χ^2 corresponds to a level of significance of ·95, the hypothesis is as unlikely to be true as if the value P = .05 were obtained. A value for P as high as .95 would indicate either that the chance of an occurrence was partly dependent on the chance of another or that sampling had not been random. For instance, the samples may have formed too large a proportion of the sampled population. I would suggest, too, that a very high level of significance be used in testing differences of catches made with instruments of variable catching power. Perhaps the ·01 level would be suitable.

The χ^2-test for variability is useful for testing randomness in sampling when distribution of objects in space may be assumed reasonably to be statistically uniform. For instance, the methods of sampling plankton catches may be tested in this way. If, however, each sample forms more than, say, $\frac{1}{30}$ of the sampled catch, it would be preferable to consider that the frequency distribution is binomial, applying the appropriate χ^2-test, which is given in Fisher (**1**), p. 71.

The Poisson distribution has been dealt with rather fully here as it is the basis of the idea of random sampling as applied to samples of which the totals are unlimited. In fact it defines random samples with unlimited totals.

The Multinomial Distribution.

As a rule in experimental work samples are made by drawing a given number of objects from the total population and by recording some measureable or countable character. Such samples may be called limited samples. All *drawn* samples, whether a given number of objects is drawn or whether a given bulk of them is drawn, are limited samples. Indeed unless the total can be regarded as distributed in the Poisson series, the sample is limited.

The observations of measureable or countable characters in a limited sample are distributed in the multinomial distribution. Assuming that in the population itself, the proportional frequencies in each frequency-group or the proportional frequencies of each count are p_1, p_2, p_3, p_4, ... p_s and that the total number of measurements or counts in the sample is n', the number of possible samples is given by the number of terms in the expansion of the multinomial

$$(p_1 + p_2 + p_3 + p_4 + \ldots + p_s)^{n'}$$

The proportional frequency of any sample a_1, a_2, a_3, a_4, ... a_s is given by the corresponding term of the multinomial, namely,

$$\frac{n!}{a_1!\, a_2!\, a_3!\, a_4! \ldots . a_s!}\, p_1^{a_1} p_2^{a_2} p_3^{a_3} p_4^{a_4} \ldots p_s^{a_s}$$

With the help of tables of logarithms of numbers and logarithms of

factorials (**2**) it is very easy to work out the probability of any given sample's arising from a known or assumed population. There are so many possible samples, however, that the probability of occurrence of any *particular* sample is minute. What we require to know is the chance of a sample's deviating more from the hypothetical population than does the observed sample. To supply the requisite knowledge fairly correctly it is assumed that the number in each frequency class is distributed about the hypothetical frequency in the class normally and with variance equal to the expected frequency. In each class therefore we have an expected frequency and variance, np_s, and an observed frequency a_s. The variance between two numbers a_s and np_s is $(a_s - np_s)^2$ and thus the ratio between observed and expected variance is

$$\frac{(a_s - np_s)^2}{np_s} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(A)}$$

which is termed χ^2, this function being always the ratio between an observed and a hypothetical variance. The sum of any numbers of values of χ^2 is distributed in the χ^2-distribution, which depends only on the number of degrees of freedom appropriate to the case under test. The expression A has one degree of freedom, and if the values of χ^2 for each frequency class were added together, the appropriate number of degrees of freedom would be the same as the number of classes were it not for the following considerations. In a limited sample the total is fixed; one degree is therefore absorbed. If the mean of the hypothetical distribution is calculated from the observations, another degree of freedom is absorbed, and a calculated variance absorbs a third. If two observed frequency distributions are compared to see whether they are likely to be samples from the same population, the ratio for each class is calculated from the sum of the pair of frequencies in that class, and the ratio of the totals is calculated from the sum of the totals. The total number of degrees of freedom applicable to the case is therefore one less than the total number of classes.

The χ^2-test of the multinomial suffers from the defect that the χ^2-distribution of the ratio of observed to expected variance is only realized if the numbers in the class in question are normally distributed. This is not the case when the mean or expected number is small. The procedure of combining the numbers in adjacent classes so as to bring the total up to at least five is usually adopted. This process really renders the test defective in that discrepancies in these classes are masked, and almost always the "fit" is exaggerated. If the test shows a significant misfit between hypothesis and observation, a misfit is definitely indicated. If, however, significant discrepancy is not shown, one should be very cautious in accepting agreement between hypothesis and observation. There is definite need of a test which does not involve, as does the χ^2-test, throwing away much of the relevant information provided by the samples.

Testing the Differences between Means of Samples.

If n' numbers are normally distributed with variance σ^2, their mean is normally distributed with variance $\frac{\sigma^2}{n'}$. The difference between any random two of the numbers is normally distributed with variance $2\sigma^2$ and the difference between the means of two random samples of n' numbers is distributed normally with variance $\frac{2\sigma^2}{n'}$. The mean difference is of course zero. If the samples are of different sizes n'_1 and n'_2, the variance of the difference between their means is $\frac{\sigma_1^2}{n'_1} + \frac{\sigma_2^2}{n'_2}$. This is the basis of the well-known test of the difference between two means. It is perfectly sound with large samples of a hundred or more. It is assumed, however, that the mean and variance of the hypothetical normal population from which the samples are assumed to have been drawn are accurately given by the sample means and variances. With small samples, the estimated means and variances are *not* normally distributed and the true means and variances of the best-fitting hypothetical population must be regarded as unknown. In any normal population, however, it may be shown that the function $\frac{\bar{x}}{s_{\bar{x}}}$, where $\bar{x}$ is the mean of a sample, and s_x is the calculated standard error of this mean, is distributed in a certain way. The distribution has been worked out and tabulated as the *t*-distribution. Its form depends on the degrees of freedom appropriate to the case under test. The *t*-test is used for examining the significance of a difference between two sample means. The hypothesis under test is that $\bar{x}$, the mean difference, is really zero, and that the observed value of t has arisen by chance of random sampling. If t is so large that it lies in one or other tail of its random sampling distribution, it may be assumed as unlikely to have arisen by chance. In this case $\bar{x}$ is considered to have a real value not due to chance. The use of the test is fully detailed in Fisher (**1**), p. 111 *et seq.*

The *t*-test is absolutely sound provided that the population to which the test is applied is not very divergent from a normal population. An observed *t*-distribution does not vary from the form appropriate to a normal population to anything like the extent to which the population observed varies. It is impossible at the present state of our knowledge to lay down hard and fast rules as to the required likeness, to the normal form, of a population to which it is intended to apply the test. The test is quite safe to apply if the population is not shown to be significantly abnormal by the tests for normality mentioned in the next section. It is probably useful in even significantly abnormal populations, provided that a high level of significance, for instance a level of .025, be used in place of .05. It is necessary also to avoid the assumption of "no difference" unless t is somewhere near the centre of its distribution. Between the levels of $P = .2$ and $P = .025$, say, it

would be well to consider the verdict as "non-proven" until further observations are made. Experiments are being carried out constantly to extend our knowledge of the applicability of this and other tests to non-normal populations.

Tests for Normality.

The χ^2-test for general divergence of a sample from normality, in spite of its limitations, is quite sufficiently crucial when used to decide whether a sample is near enough to normal form for the *t* or the *z*-test to be applicable. In certain cases, however, a sample distribution may be very skew, very flat topped or very narrow topped. These particular forms of divergence may be very unlikely to have arisen by chance in a sample from a normal population, in spite of a fair likelihood that the individual divergence in frequency classes has arisen in that way. It is sometimes useful therefore to apply the *g*-tests (Fisher (**1**) p. 53 *et seq.*) for particular kinds of divergence from normality.

Correlation and Regression.

This subject has been much obscured by the prevalent use of the word regression to mean merely the expression of one variate in terms of another. The normal theory of correlation and regression applies only to a bivariate surface showing the frequency distribution of paired occurrences of values of two variates each of which is normally distributed. Thus, whichever variate be taken as the independent variate when considering regression, its variation is just as much fixed by the normal form of its frequency distribution as is that of the dependent. It is not independent in the sense that we may give it any value we please. The allowable values are fixed. The theory of regression cannot justifiably be extended to include bivariate or multivariate distributions in which one or more of the variates are given arbitrary values. The bivariate or multivariate surface involved in that case may not be anything like a normal correlation surface. The form of this is equally fixed by either variate. Certainly normal regression theory may be extended to more than two variates but only if all of them are normally distributed.

Forms of "regression" other than that applicable to normal theory may be used perfectly justifiably either as a means of expressing one variate in terms of another or as a means of eliminating variance as one of the processes of the analysis of variance. The theory of non-normal regression of this kind cannot, however, be combined with that of normal regression and correlation theory. Attempts to effect this combination have merely confused the issue.

The easiest way to approach the normal theory is by way of a bivariate surface of two independently varying quantities distributed binomially.

Let us suppose that we have a variate with binomial frequency distribution given by

$$N_1\left(\frac{1}{2}+\frac{1}{2}\right)^{n_1}$$

and another whose simultaneous variation with the first we are studying and whose distribution is given by the binomial

$$N_2\left(\frac{1}{4}+\frac{3}{4}\right)^{n_2}$$

where $n_1 = n_2$, and N_1, the number of observations of the first, of course is equal to N_2, the number of observations of the second. If, now, the variations of the two quantities are quite independent, the proportional frequency of simultaneous occurrence of 0 in one and 0 in the other is given by the product of the first terms of the two binomials. The frequency of simultaneous occurrence of r_1 in the first and r_2 in the second is given by the product of the $(r_1 + 1)$th term in the first and the $(r_2 + 1)$th term in the second. All the products may be written down in a two-fold table, the first variate being measured along the horizontal or x-axis, the second along the y-axis, the frequency of any simultaneous occurrence being measured by a number in the two-fold table opposite the appropriate points on the two axes, or by a column standing up vertically from the paper. The proportional spread of the bivariate population may be measured by the rectangle $\sigma_x\sigma_y$. If n_1 and n_2 are made infinite, we obtain a normal no-correlation distribution of two variates x and y, its proportional spread being measured by $\sigma_x\sigma_y$. Consider now the cross-product sum $S(xy)$, x and y being measured from their means. If the variation of x is independent of that of y, any positive value of x will occur equally often with positive and negative values of y; thus $S(xy)$ will be equal to zero. If the variations of x and y are connected with or dependent on each other, directly or inversely, $S(xy)$ will be equal to a positive or negative number. Now the connected part of the variation measured by $S(xy)$ may be considered as the variation of a fraction of the bivariate population of which the proportional spread is measured by $\sigma_x\sigma_y$. If instead of expressing the spread in proportional terms we retain the number in the original population of pairs, namely N, we may use the root of the product of total sums of squares $\sqrt{S(x^2)\,S(y^2)}$ to measure the total variation in two dimensions of the original population, and of this the part $S(xy)$ may be expressed either as a sum of x^2 values or as a sum of y^2 values, if allowance is made for the different scale of measurement of x and y. Thus of the original population with volume N the fraction

$$\frac{S(xy)}{\sqrt{S(x^2)\,S(y^2)}} \text{ or } r\mathrm{N}$$

may be expressed by a curve of error standing up from the paper, its

axis of abscissae making the angle $\tan^{-1}\frac{\sigma_y}{\sigma_x}$ with the x-axis and readable in terms of either variate, the remaining part of the population, namely $(1 - r)N$, having still to be expressed by a bivariate table or surface of no-correlation. Considering now the original population of one variate alone, say x, with the proportional variation measured by σ_x, we find that we have reduced this proportional variation by correlation exactly as if we had taken a random sample of r x-values from the original N x-values, leaving, however, the number N in the population as before. We cannot, however, utilize the x-values in this argument since, as x is measured from its mean, $NS(x) = 0$ and $rNS(x) = 0$. However, we may say that correlation acts as if r^2 of the N original x^2-values were removed, though N, the number of variants, actually remains as before. Thus the fraction r^2 of the variance is dependent on and may be expressed as variance of the other, the fraction $1 - r^2$ being independent.

The regression line of one variate on the other is the weighted mean of two lines, one of which is the common axis of abscissae, mentioned above, the other being the horizontal line through the mean of whichever variate is considered as the dependent variate. The weights respectively are r and $1 - r$. Thus if y is the dependent variate, the two lines are

$$y = \frac{\sigma_y}{\sigma_x} x \text{ (weight } r)$$

$$y = \bar{y} \text{ (weight } 1 - r)$$

giving

$$y = r\frac{\sigma_y}{\sigma_x} x + (1 - r)\bar{y} \quad \ldots\ldots\ldots\ldots\ldots \text{(B)}$$

If y is measured from its mean, the second term vanishes and (B) becomes

$$y = r\frac{\sigma_y}{\sigma_x} x \text{ or } y = bx,$$

where b is termed the regression coefficient of y on x. Each column of the correlation table contains a population of y, of which the total frequency is dependent on the x-distribution, of which the mean is given by the regression line, and of which the variance is equal to

$$(1 - r^2)\,\sigma_y^2$$

The scale of measurement of r is thus linear if considered as expressing the fraction of the original bivariate distribution which may be expressed as a curve of error common to either variate. The regression coefficients b_y and b_x only differ from each other and from r when $\sigma_y \neq \sigma_x$. The differences arise solely from the fact that the variations of x and y are measureable on different scales, so that the interconnected parts of the variations of x and y are not *equal* but proportional to each other. The two regression coefficients' being equal when $\sigma_y = \sigma_x$ does not imply of course that the two regression lines are the same.

They are measured on different coordinate axes, and only coincide when $r = 1$. The equations $y = bx$ and $x = by$ do not represent the same line.

An apparent correlation may arise by chance, through errors of random sampling, when there is no real correlation. The distribution, in random samples, of the estimated correlation r is very skew at the ends of its range even with large samples. To test the *significance* of an observed value of r, that is to say, to test whether r is significantly different from zero, it is always best to transform r into a function z where

$$z = \frac{1}{2}\left[\log_e (1 + r) - \log_e (1 - r)\right]$$

The standard error of z is given by

$$\sigma_z = \frac{1}{\sqrt{n' - 3}}$$

where n' is the number of pairs of observations in the correlation table. The distribution of z may be taken to be normal in most cases. It is only necessary then to find whether the observed value of z is, say, larger than $2^1/_2$ times the standard deviation, which applies of course to $z = 0$.

Curved Regression Lines.

Non-linear regression, unless it may be reduced to linear regression by the substitution of functions of the observations, has not the same status among simple explanations of phenomena as linear regression. It is more of the nature of graduation formulae. As such, curved regression lines may be of great practical service.

If a linear regression coefficient has been calculated and found by the t-test to be significant, we still cannot judge whether regression is linear or not, but merely whether there is a significant linear term. To test for linearity of regression it is necessary to calculate the quadratic and sometimes the cubic term of the general regression equation

$$y = a + bx + cx^2 + dx^3 + \ldots\ldots$$

The calculation of these terms is dealt with fully in (**1**).

If a distribution contains a component due to a non-linear regression the distribution is never normal in form, but may be bimodal, multimodal, flat topped, or skew. Some help in deciding whether there is a component of this kind may be obtained from (**3**).

The search for and calculation and testing of regression is best carried out as one of the processes of the Analysis of Variance, which is perhaps the most powerful statistical tool known. Before discussing the technique of this analytical method, however, it is necessary to consider the exact meaning of regression.

The Meaning of Regression.

A value of y on the regression line corresponding to a given value of x is the y-value which is most likely to occur with that value of x *in the particular population from which the regression is calculated.* Since a component of the y-value is merely the mean of the general y-population, it is clear that variation in the form of this population affects the probability of occurrence of each *y-value.* Regression does not therefore give *in general terms* the values of y and x between which correspondence is greatest, though it gives the *extent* of the correspondence. The value of y which corresponds best to a value of x is obtained by considering that all y-values are equally likely to occur in the general y-population. The population is "rectangular" over the whole range considered. The values of x and y which most nearly correspond to each other are then given by the equation.

$$\frac{y}{\sigma_y} = \frac{x}{\sigma_x}$$

which is the equation to a straight line making the angle $\tan^{-1}\frac{\sigma_y}{\sigma_x}$ with the x-axis. The line makes the angle of 45° with both axes when $\sigma_y = \sigma_x$. This equation answers the question: What value of y would occur most often with x_s if all y-values were equally common? The regression equation answers the question: What value of y would occur most often with x_s if the x-values were distributed in the normal distribution which best fits the observed x-distribution? The answers in both cases are unique. The two values of y given are the means of different distributions.

Regression and Correlation in Growing Organisms.

The application of normal correlation theory to bivariate distributions implies equality of proportional variation in all columns of the correlation table. This cannot occur in the case of the lengths of growing organisms and their parts, since absolute variation in these when they are small must necessarily be much less than when they have grown large. Generally it is found that variation in any column or row of lengths is approximately proportional to the mean length of the row or column. In this case, calculations of correlation and regression coefficients should be carried out on the logarithms of the lengths instead of the actual lengths.

Back-Calculation of Lengths of Fish from their Scales or Otoliths.

L e a's method of back-calculation is not a regression method, and no regression method is suitable for testing its soundness. The most suitable method I can think of for this purpose is the following. Measure large samples of fish at all available ages of the species in question, taking a scale from each fish and as nearly as possible from the same place on each fish. Measure the scales. Subtract from the

logarithm of each fish-length the logarithm of the corresponding scale-length. The scale of measurement used is indifferent. The log-differences corresponding to all ages of the fish should be samples from the same population of log-differences if L e a's method is to be applied. The χ^2-test may be used as a criterion for judgment whether the required conditions obtain. If the lengths of several age-classes of the fish are available for comparison an analysis of variance of the simplest form may be carried out on the log-differences.

The Analysis of Variance.

The procedure of the analysis of variance consists of dividing up a distribution of numbers, forming our data, into various classes and subclasses, then applying tests to see whether the numbers in these classes and subclasses may be regarded as random samples from the original distribution. If the tests prove that some or all of the sub-distributions are not random samples from the whole, then it is inferred that the subdivision of the whole distribution shows a "significant effect". The subdivisions may be made in many different ways, some of them very complicated. I shall deal here with only the simplest applications of the method.

I am going to ask my readers to perform a small practical experiment which will help them very much in understanding the theory of the analysis of variance. Please, then, take a piece of cardboard and cut it into 48 equal pieces. On these pieces write down numbers, 0 to 10, one on each piece, the numbers being approximately normally distributed. A suitable set of frequencies may be obtained by expanding the binomial

$$48\left(\frac{1}{2}+\frac{1}{2}\right)^{10}.$$

There will then be eleven different numbers, including 0, the number of cards with 0 on them being given by the first term of the expansion, the number of cards with 10 being given by the last term, and so on. Do not, however, follow the exact law given by the binomial but change the theoretical frequencies slightly. Calculate the sample variance s_t^2 of the whole set of numbers. This is given by

$$\frac{S\,(x-\bar{\bar{x}})^2}{47}$$

where x is any number, $\bar{\bar{x}}$ is the mean number, and 47 is the total number of degrees of freedom, since $\bar{\bar{x}}$ is calculated from the numbers. Now put all the cards into a box and shake them up well until thoroughly mixed. Without looking at the numbers divide the cards into four heaps of twelve cards each. Write the letter A on all the cards of one heap, the letters B, C, and D on the cards of the other heaps respectively. Calculate the mean and variance of the numbers in each heap; the variances being

$$\frac{S\,(x_A-\bar{x}_A)^2}{11},\quad \frac{S\,(x_B-\bar{x}_B)^2}{11},\ \text{etc.}$$

Assuming that the division into heaps is truly random with regard to the numbers, these variances within classes are efficient estimates of the variance of the whole set of numbers. Furthermore, the total sum of squares "within classes" divided by the total degrees of freedom within classes is also an efficient estimate of the variance of all the numbers. The total sum of squares "within classes" may be written

$$\frac{S_A^D (x - \bar{x})^2}{44}$$

There are thus three degrees of freedom remaining. These belong to the sum of squares of the differences between the class means and the general mean. It may be shown that

$$\frac{12\, S_A^D (\bar{x} - \bar{\bar{x}})^2}{3}$$

or the "variance between classes" is an efficient estimate of the general variance. It will be found that the sums of squares between and within classes total up to the total sum of squares.

There is no necessity that the classes should all contain an equal number of cards. If they contain, say, 9, 10, 12, 17 cards respectively, the variance within classes is calculated as before but for the variance between classes we have

$$\frac{9\, S (\bar{x}_A - \bar{\bar{x}})^2 + 10\, S (\bar{x}_B - \bar{\bar{x}})^2 + \ldots .}{3}$$

This expression is usually written

$$\frac{S n_p (\bar{x}_p - \bar{\bar{x}})^2}{r - 1}$$

where n_p is the number of cards in class p, and r is the number of classes. The sum of squares within classes is usually written

$$\frac{S (x_p - \bar{x}_p)^2}{n - r + 1}$$

where x_p is any number in class p and $\bar{x}_p$ is the mean of class p, and n is the *total* number of degrees of freedom.

The easiest way to calculate the sum of squares within classes is as follows:—

For each class square all the numbers and from the sum of these in each class subtract mean $\times$ total, thus:—

$$S (x_p - \bar{x}_p)^2 = S (x_p)^2 - \bar{x}_p\, S (x_p)$$

The sum $S n_p (\bar{x}_p - \bar{\bar{x}})^2$ is calculated by multiplying the mean by the total in each class and from the sum of the products subtract the product of the general mean and grand total (i. e. the sum of all the numbers), thus:—

$$S n_p (\bar{x}_p - \bar{\bar{x}}) = S (\bar{x}_p S x_p) - \bar{\bar{x}} S (x)$$

We then have for our analysis:—

	SS	DF	Variance $= {}^{SS}/_{DF}$
Within Classes	$S(x_p - \overline{x}_p)^2$	$44 = n_2$	s_w^2
Between Classes	$Sn_p(\overline{x}_p - \overline{\overline{x}})^2$	$3 = n_1$	s_b^2
Total	$S(x - \overline{x})^2$	47	s_t^2

We are interested now in seeing whether the two estimates S_w^2 and s_b^2 are significantly different. It has been found that the logarithm of the square root of the ratio of one estimate of variance to the other has a distribution in random samples which depends only on the degrees of freedom n_1 and n_2. The function is called z and in truly random samples from a normal distribution z is distributed about zero in a way which has been calculated and tabulated. The number of degrees of freedom applicable to the larger estimate, whichever it be, is called n, for entering the z-table. If z of our observations is further from zero, the centre point of the chance z-distribution, than would occur by chance in one case out of twenty, it is considered that the observed z is unlikely to have arisen by chance from really random division of our numbers. It is therefore assumed that this has not been random. There is an *effect* of the division. If the variance between classes is the greater, it is assumed that there is a real difference between the class-means.

The process allows a whole set of means to be compared. It not only eliminates the tedious work of comparison in pairs, but is actually a much superior process to that in that it considers the distribution of these as a whole.

Regression is a way of expressing the difference between means of classes in a connected way. If, then, there is no significant difference between the means there is no point in calculating a regression, since it will turn out to be not significant when tested. Before working out a correlation or regression therefore, the simple analysis of variance into that between and within classes should be carried out. If that between classes proves to be significant, the calculation of regression may be proceeded with. It may not turn out to be significant since the differences between means may be distributed along a line parallel to the axis of the independent variate.

To test the significance of regression we calculate the "sum of squares removed by regression", allot the sum its proper number of degrees of freedom and compare the result, the "variance removed by regression", with the variance within classes. If a straight regression line has been fitted, the sum of squares removed by regression is given by $bS(xy)$ and the number of degrees of freedom is 1, since x's are measured from the mean. I have given the designation y to the independent variate, x being used for the observations. If the variance removed by regression is significantly greater than the variance within classes, then the difference between means is at any rate *partially* expressed by the regression. If there is no significant difference between

the regression component and the "between classes" component of variance, regression may be taken as expressing the whole of the variance between classes. The case of non-linear regression is dealt with fully in (**1**). If the original population be very non-normal it can often be "normalized" by means of a non-linear regression on time or some other variate; the analysis may be then proceeded with, the effect of time or other variate having been eliminated.

The above method of dealing with regression by the analysis of variance is simpler and more easily combined with other processes than the old way of calculating regression or correlation as an isolated process. There is really no need in most cases to trouble ourselves about correlation, since if linear regression is significant, correlation is also significant.

Reverting once more to our numbered cards, which we have divided into four lots of twelve each, let us subdivide these lots each into four subclasses of 3 cards each. Give the cards in one subclass of each lot the letter *a*, the next the letter *b*, and so on. Thus we have subclasses A*a*, A*b*, A*c*, A*d*; B*a*, B*b*, B*c*, B*d*; and so on. We can use a table of double entry to represent these subclasses and the numbers in them as in table 2.

Table 2.

	A	B	C	D	Totals
a					S(*a*)
b					S(*b*)
c					S(*c*)
d					S(*d*)
	S(A)	S(B)	S(C)	S(D)	Grand Total

We may now divide our 47 degrees of freedom into 2 × 16 or 32 for "variance within subclasses", and 15 for "variance between means of subclasses." These 15 degrees of freedom may be subdivided into 3 for variance between *a*, *b*, *c*, and *d*, 3 for variance between A, B, C, and D, and 3 × 3 or 9 for interaction between classes A, B, C, D and *a*, *b*, *c*, *d*. Interaction means the difference in the *a*-effect according to whether it is combined with the effect of class A, B, C, or D, and so on. As an example, A, B, C, D may be different species of fish, *a*, *b*, *c*, *d* different areas. The entries S(A), S(B) and so on represent *total* occurrence of the four species separately, the entries S(*a*) and so on represent general landings of fish in the areas taken separately, while the "*interaction*" represents difference of landings of any fish according to area. The calculation of the sums of squares necessary for testing the significance of any of the above effects is very simple. The sum of squares for difference between classes *a*, *b*, *c*, *d* is given by mean A × total A plus mean B × total B, etc., minus grand mean by grand total. The sum of squares between *a*, *b*, *c*, *d* is calculated in the same way. The interaction sum of squares is obtained by subtracting the above two sums from the sum of squares between all

subclasses. This last sum is given by mean aA $\times$ total aA plus mean bB $\times$ total bB up to mean dD $\times$ total dD, minus grand mean by grand total.

In our example, each card represents an "observation". If in subclass a there are more cards in class A than there are in class B, C, D, then the class Aa is over-represented, this having the effect of entangling or confounding the effect of A with the effect of a. In this sort of case the analysis of variance is much more complicated than when representation of one classification is equal in the other. The required treatment is exemplified in (**4**).

The analysis of variance may be extended to far more than two cross-classifications. Since, however, unequal representation in subclasses almost always occurs in fishery work, it is of little use to attempt the disentangling of more than two cross-effects.

Conclusion.

I have attempted in the foregoing pages to explain why it is necessary to assume the existence of a chance element in studying phenomena. In general terms the action of chance implies that if a thing can happen in many different ways, the proportional number of times it *will* happen in any particular way will be, in the long run, equal to the proportional number of times it *can* happen in that way. The statement of the proportional number of times the thing *can* happen in each way is the definition of the law of chance involved. I have dealt only with some of the simplest laws of chance, since these have in the past proved of great practical service in statistics. It is quite impossible within the bounds of a short paper to give any useful account of the application of the complex system of laws of chance employed by Professor Karl Pearson and his school of statisticians. Readers interested in the subject are referred to Biometrika and to (**2**).

The present paper does not pretend to be anything like a complete exposition even of those parts of statistical philosophy which have been touched upon: it is an attempt to explain fundamentals. Explanations of these in most books on the subject are too short to be easily intelligible, or are couched in mathematical phraseology in such a way as to make it appear that statistics consists merely of a set of rules having little or no foundation in common sense.

Bibliography.

(1) R. A. Fisher. Statistical Methods for Research Workers. Fourth Edition. Oliver and Boyd, Edinburgh, 1932.

(2) Tables for Statisticians and Biometricians. Edited by Karl Pearson, F.R.S. Cambridge University Press.

(3) H. J. Buchanan-Wollaston. On the Component of a Frequency Distribution ascribable to Regression. Journ. du Conseil, Vol. X, No. 1. Copenhagen, 1935.

(4) H. J. Buchanan-Wollaston. Some Modern Statistical Methods etc. Journ. du Conseil, Vol. VIII, No. 2. Copenhagen, 1933.

Die Schollenbevölkerung der Deutschen Bucht im Jahre 1935.

Von

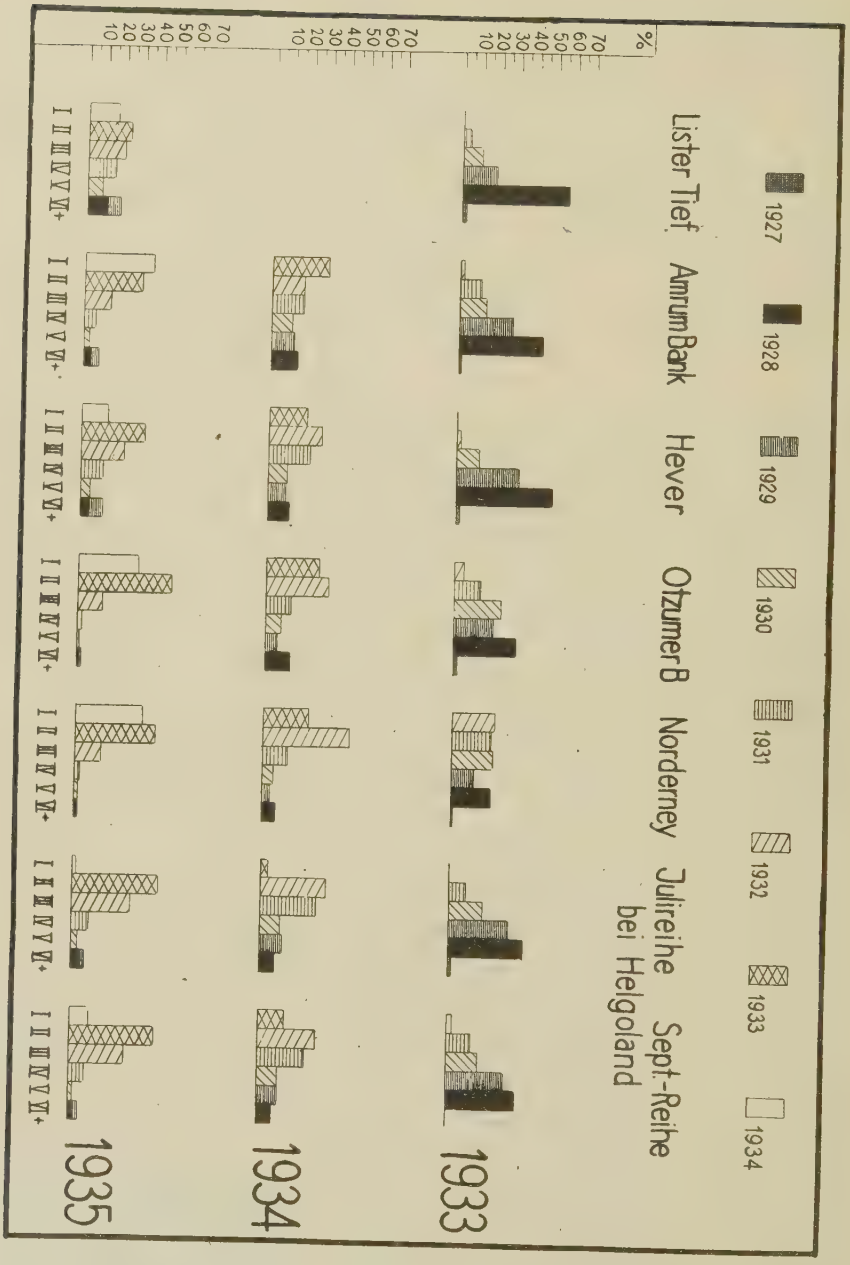
Adolf Kotthaus,
Helgoland.

WIE bekannt sind im Frühling der Jahre 1929 bis 1933 umfangreiche Aufnahmen des Schollenbestandes der Deutschen Bucht durch den Reichsforschungsdampfer "Poseidon" durchgeführt worden. In den beiden letzten Jahren stand der "Poseidon" für diese Zwecke nicht zur Verfügung. Statt dessen wurden Untersuchungen geringeren Umfanges mit dem Dienstfahrzeug der Biologischen Anstalt, M. S. "Augusta" vorgenommen. Diese beschränkten sich auf das flache Gebiet der Deutschen Bucht etwa innerhalb der 25 m.-Linie. Auch wurden nicht alle Schnitte des "Poseidon" befischt (1934 nur Norderney, Otzumer Balje und Hever im Mai und Amrum-Bank im Juni; 1935 Lister Tief und Hever im Mai und Amrum-Bank, Otzumer Balje und Norderney im Juni). Ungünstig war es, dass die Untersuchungen nicht im zeitlichen Zusammenhang, sondern infolge der Ungunst der Witterung nur mit längeren Unterbrechungen durchgeführt werden konnten.

Trotzdem gestattet diese Bestandsaufnahme in Verbindung mit den seit Jahren bei Helgoland im Juli und September vorgenommenen Untersuchungen ein allgemeines Urteil über die jetzige Beschaffenheit der Jungschollenbevölkerung der Deutschen Bucht.

Bis zum Jahre 1933 herrschte im ganzen genommen der Jahrgang 1928 durchaus vor (vergl. hierzu Tab. I u. II). Im Gebiet vor der ostfriesischen Küste allerdings war auch Jahrgang 1930 von einiger Stärke und behauptete als Altersgruppe III seinen Platz neben dem Jahrgang 1928, während er vor der nordfriesischen Küste ebenso bedeutungslos war wie die anderen jüngeren Jahrgänge.

Das Frühjahr 1934 brachte einen starken Rückgang des Anteils des Jahrganges 1928 von fast $^1/_2$ auf ca. $^1/_{10}$ der Bevölkerung. Die Angehörigen dieses Jahrganges waren 1933 einer sehr intensiven Befischung unterworfen, (sie hatten z. B. 76 % der von den deutschen Kuttern gelandeten Schollen gestellt), wodurch ihre Zahl schon stark gelichtet sein muss. Vornehmlich aber dürften sie im Alter von 6 Jahren soweit herangewachsen gewesen sein, dass sie die Jungfischgründe der Deutschen Bucht verliessen. — Auch der Anteil des Jahrganges 1929 ging



Alterszusammensetzung des Schollenbestandes der Deutschen Bucht in den Jahren 1933—1935.
(Prozentuale Verteilung der Altersgruppen auf den einzelnen Untersuchungsschnitten.)

stark zurück, und gleichzeitig stieg der Anteil der jungen Jahrgänge 1932 und 1933 auf etwa $^1/_3$ bezw. $^1/_4$ der Bevölkerung. Wenn auch ein Vergleich der Bevölkerungsdichte von 1934 mit den früheren Jahren infolge des Wechsels der Untersuchungsweise leider nicht durchführbar ist, so ist doch der Schluss gerechtfertigt, dass diese neuen Jahrgänge (1932 und 1933) nicht etwa reich sind, sondern höchstens von mässiger Stärke. Ihr vergleichsweise hoher Anteil war nur durch den Mangel an älteren Schollen, also durch das Verschwinden des alten reichen Jahrgangs und durch die Armut der Jahrgänge 1929 bis 1931 in unserem Gebiet bedingt.

Tabelle I.

Relative Alterszusammensetzung (in %) des Schollenbestandes.

Altersgruppe:		0	I	II	III	IV	V	VI	VII+	Untersuchte Zahl
1933 (Poseidon)			*1932*	*1931*	*1930*	*1929*	*1928*	*1927*	*1926—*	
Mai	Norderney		22.7	21.3	22.3	12.1	20.5	0.9	0.2	6,180
	Otzumer Balje		5.0	14.2	25.0	20.9	32.9	1.8	0.1	6,738
	Hever		0.2	2.0	12.0	32.8	51.0	1.8	0.2	7,046
	Amrum-Bank		1.7	11.2	14.1	28.0	43.6	1.3	0.1	5,628
	Lister Tief		0.4	4.2	10.1	18.2	65.8	1.2	—	8,482
1934 (Augusta)			*1933*	*1932*	*1931*	*1930*	*1929*	*1928*	*1927—*	
Mai	Norderney		24.4	45.5	13.3	6.3	4.0	6.5	—	1,319
	Otzumer Balje		28.1	32.9	12.5	7.8	6.1	10.9	1.6	1,211
	Hever		19.8	28.2	22.0	10.1	8.9	11.0	—	1,154
Juni	Amrum-Bank		30.0	16.8	16.7	10.9	11.5	13.8	0.4	2,494
	Lister Tief		—	—	—	—	—	—	—	—
1935 (Augusta)		*1935*	*1934*	*1933*	*1932*	*1931*	*1930*	*1929*	*1928—*	
Juni	Norderney		35.7	43.2	14.1	2.8	2.0	1.0	1.2	2,910
	Otzumer Balje		32.4	49.8	13.1	2.4	0.7	0.7	0.9	7,577
Mai	Hever		14.0	34.0	22.9	11.7	4.9	6.9	5.5	2,505
Juni	Amrum-Bank	0.7	36.7	31.4	13.6	6.4	3.4	3.6	3.9	1,903
Mai	Lister Tief		16.1	22.7	19.8	15.4	8.3	6.9	10.7	2,061

Die Alterszusammensetzung der Frühjahrsfänge von 1935 (Tab. I) lässt, wie zu erwarten, einen weiteren Rückgang des Anteils älterer Schollen erkennen. Jahrgang 1928, obwohl immer noch sichtlich reicher als Jahrgang 1929, spielt in der Gesamtbevölkerung keine Rolle mehr. Ebenso sind die Prozentsätze der armen Jahrgänge 1930 und 1931 klein, und der Jahrgang 1932 in der III-Gruppe ist nur mit 13 bis 23 % am Gesamtbestand beteiligt. Damit wird die Auffassung, dass er nicht reich ist, durchaus bestätigt. Wieder stellen die I- und II-Gruppen, die Jahrgänge 1933 und 1934, den weitaus grössten Teil des Bestandes. Von Jahrgang 1933 dürfen wir annehmen, dass er von mässiger Stärke ist, zumal auch sein Anteil an den Sommer- und Herbstfängen bei Helgoland (Tab. II) ziemlich hoch ist. "Reich" ist er jedoch nicht. Über den Ausfall des Jahrgangs 1934 lässt sich heute noch kein endgültiges Urteil fällen, da die I-Gruppe bei unseren

Tabelle II.

Relative Alterszusammensetzung (in %) des Schollenbestandes.

Altersgruppe:	0	I	II	III	IV	V	VI	VII+
Julireihe bei Helgoland.								
1931	—	—	31.2	62.1	6.0	0.7	—	—
1932	—	—	5.6	29.4	61.1	3.7	—	—
1933	—	—	8.8	17.9	31.6	40.2	1.5	—
1934	—	3.5	35.2	29.8	11.3	12.1	8.1	—
1935	—	2.3	46.2	31.5	9.5	3.4	3.4	3.7
Septemberreihe bei Helgoland.								
1931	—	3.7	26.4	63.9	5.5	0.5	—	—
1932	—	2.2	9.5	30.5	54.4	3.4	—	—
1933	—	3.1	12.5	16.7	31.2	36.6	—	—
1934	—	14.4	31.2	24.8	10.6	10.9	7.6	—
1935[1])	—	10.1	45.0	28.9	8.5	2.5	3.5	1.5
Heverschnitt September.								
1932	—	6.1	13.9	29.9	47.3	2.7	—	—
1933	—	11.5	19.4	15.5	25.1	28.5	—	—
1934	5.5	28.8	23.9	27.6	7.2	8.3	6.5	—
1935[2])	—	—	—	—	—	—	—	—

[1]) 22. und 23. Oktober 1935.
[2]) 1935 wurde der Heverschnitt im September nicht befischt.

Fahrten niemals voll erfasst wird. Es liegen zwar Anzeichen vor, dass er reicher sein muss als die Jahrgänge 1933 bis 1930; jedoch dürfte er beiweitem nicht den Jahrgang 1928 erreichen. Jedenfalls steht fest, dass von 1929 an bis wenigstens 1933 kein wirklich gutes Nachwuchsjahr für die Schollenbevölkerung der Deutschen Bucht gewesen ist.

Was die Wachstumsgeschwindigkeit anbetrifft, so erschwert hier der späte Zeitpunkt der Untersuchungen des Frühjahrs und des Herbstes 1935 den Vergleich mit früheren Beobachtungen. Die Durchschnittslängen der Altersgruppen III-V (Tab. III) waren bei allen Untersuchungsreihen mit wenigen Ausnahmen höher, und zwar um 0.7 bis über 2 cm. höher als im Vorjahre. Wenn nun auch in einigen Fällen der spätere Untersuchungstermin des Jahres 1935 daran einen Anteil gehabt haben wird, (bei Otzumer Balje und Norderney im Frühling, bei Helgoland im Herbst, nicht aber auf den nordfriesischen Schnitten und bei Helgoland im Juni) so steht doch fest, dass die Zunahme der Wachstumsgeschwindigkeit, die zuerst 1933 bei den jüngsten Altersgruppen zu erkennen war, noch andauert. Die Durchschnittslängen der II-Gruppe — Jahrgang 1933 — dagegen waren fast ausnahmslos etwas geringer als 1934. Es steht zu hoffen, dass dies seine Ursache in der etwas grösseren Stärke der jüngsten Jahrgänge 1933 und vor allem 1934 hat.

Es ist übrigens bemerkenswert, dass die Durchschnittslängen, wie sie 1930 bei den Jahrgängen 1925, 1926 und 1927 festgestellt wurden, noch nicht wieder erreicht sind.

Tabelle III.

Durchschnittslängen der Altersgruppen (in cm. für Männchen + Weibchen)

Altersgruppe:			I	II	III	IV	V
A. Norderney	Juni	1930		14.0	20.0	24.6	28.3
	Mai	1931		14.9	18.8	24.1	27.3
	April	1932		13.1	16.4	19.9	23.7
	Mai	1933		13.5	17.4	20.7	23.4
	Mai	1934		13.6	16.8	20.6	25.1
	Juni	1935		13.4	18.9	22.4	25.1
B. Otzumer Balje	April	1932		13.3	16.6	19.9	23.3
	Mai	1933		14.2	17.2	19.8	23.1
	Mai	1934		13.3	17.0	21.2	23.4
	Juni	1935		13.5	18.6	20.8	24.7
C. Hever	Juni	1930		12.9	19.3	23.5	26.0
	Mai	1931		11.8	16.5	23.1	26.7
	April	1932		13.2	14.8	18.2	24.0
	Mai	1933		13.7	17.2	18.8	21.6
	Mai	1934		14.2	16.2	18.3	20.9
	Mai	1935		13.4	18.5	20.3	23.0
D. Amrum-Bank	Juni	1930		13.4	18.9	23.0	25.8
	Mai	1931		12.1	15.6	22.7	26.4
	April	1932		13.0	15.6	18.6	25.4
	Mai	1933		12.4	16.4	18.9	21.5
	Juni	1934		14.7	17.3	20.1	21.6
	Juni	1935		14.4	18.6	20.8	23.4
E. Lister Tief	Juni	1930		12.5	18.3	22.3	25.4
	Mai	1931		11.8	15.1	22.5	25.9
	April	1932		12.8	16.5	20.0	25.8
	Mai	1933		13.3	17.8	19.5	21.9
		1934		—	—	—	—
	Mai	1935		13.1	18.6	20.9	22.9
F. Julireihe		1931		13.9	17.5	22.4	26.7
Helgoland		1932		15.3	16.7	19.7	23.4
		1933		16.6	18.1	19.4	21.5
		1934		16.7	18.3	20.1	21.5
		1935		15.3	19.2	21.4	23.6
G. Septemberreihe		1931	13.4	15.1	18.3	23.1	26.9
Helgoland		1932	13.3	16.0	17.3	19.9	23.9
		1933	13.5	17.0	18.5	19.8	22.0
		1934	13.8	17.8	19.3	21.2	22.5
	Okt.	1935	15.2	18.1	21.5	23.3	25.2
H. Hever, September		1932	12.6	15.6	17.3	20.2	23.6
		1933	13.0	15.1	17.2	19.8	22.8
		1934	12.6	16.6	18.1	20.2	22.1
		1935	—	—	—	—	—

Infolge der Wachstumsverbesserung sind die Anteile der marktfähigen Schollen an den einzelnen Altersgruppen gestiegen. Der Anteil Schollen über 23 cm. betrug bei der

Altersgruppe	III	IV	V
Mai 1933	1 %	6 %	31 %
Frühjahr 1935	3—8 %	10—32 %	46—82 %

Tabelle IV.

Prozentuale Verteilung der Schollen über 23 cm. auf die Altersgruppen, 1935.

Altersgruppe:	II	III	IV	V	VI	VII+	Zus.	Ganzer Fang
Geburtsjahr:	*1933*	*1932*	*1931*	*1930*	*1929*	*1928–*	Stück	Stück
Norderney	1.3	12.8	16.0	30.1	18.6	21.1	156	2,910
Otzumer Balje ..	1.7	28.3	16.2	14.8	16.6	22.4	290	7,577
Hever	0.3	5.5	8.1	17.3	33.7	35.2	347	2,505
Amrum-Bank ...	1.1	3.8	9.2	20.7	28.3	37.0	184	1,903
Lister Tief	0.2	2.7	13.5	19.4	22.5	41.7	408	2,061
Julireihe	1.0	13.0	21.2	16.8	20.9	27.0	292	2,602
Septemberreihe ..	6.3	34.9	22.9	11.3	16.2	8.3	567	2,991

Trotzdem stellt im Frühjahr im nordfriesischen Gebiet, ja sogar auch im Sommer bei Helgoland Jahrgang 1928 immer noch den grössten Anteil der Schollen über 23 cm. (Tab. IV). Bei Norderney dagegen herrscht Jahrgang 1930 (V-Gruppe), bei Otzumer Balje im Juni und bei Helgoland im Oktober gar Jahrgang 1932 in der III-Gruppe unter den grösseren Schollen vor. Bückmann und Kotthaus haben bereits darauf hingewiesen, dass die Erneuerung der Schollenbevölkerung im Gebiet vor der ostfriesischen Küste schneller vor sich geht, und dass die Jahrgänge 1930 und 1932 hier auch verhältnismässig stärker sind als vor der nordfriesischen Küste (Rapp. et Proc.-Verb., Vol. XCIV, 3ème Partie, 1935).

Die Nachwuchsmenge ist für die nächste Zeit ausgesprochen gering. Von den Jahrgängen 1928 und 1929 ist für die Zukunft nicht mehr viel zu erwarten. Die für die Fischerei in der Deutschen Bucht ausschlaggebenden Altersgruppen IV bis VI werden im kommenden Jahr von den Jahrgängen 1930 bis 1932 gestellt. Diese sind aber für unser Gebiet — wie festgestellt — im ganzen genommen arm. Hiernach müssen wir ein Jahr schlechter Schollenerträge erwarten. Diese ungünstige Lage wird wahrscheinlich durch die Steigerung der Wachstumsgeschwindigkeit etwas gemildert werden, da ein verhältnismässig grosser Anteil der III- und IV-Gruppe nutzbare Grösse erreichen wird.

Die Untersuchungen in See sind in den letzten beiden Jahren, wie erwähnt, eingeschränkt worden, und zwar zugunsten einer intensiveren Überwachung der Schollenanlandungen der deutschen Kutter. Die endgültigen Ergebnisse dieser Arbeiten liegen gegenwärtig noch nicht vor. Nach mündlicher Auskunft von Dr. Lundbeck, Wesermünde, und Dr. Schmidt, Hamburg, bestätigen die vorläufigen Befunde unsere hier geschilderten Schlussfolgerungen in allen Punkten. Eine Veröffentlichung über die Marktuntersuchungen ist noch vor Beginn der neuen Schollenfangzeit zu erwarten.

The Decline in the Lowestoft Plaice Fisheries.

By

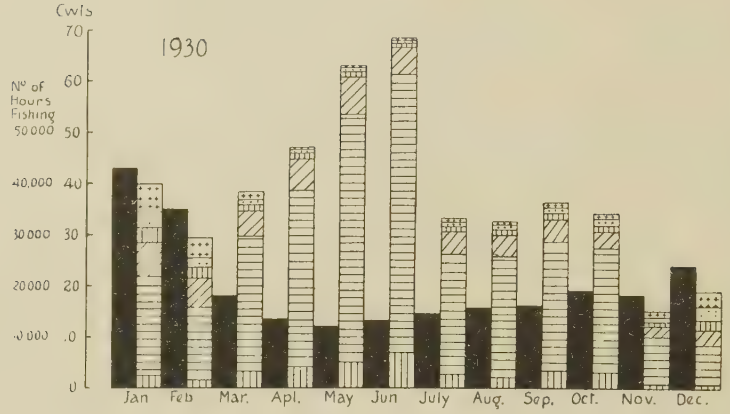
D. E. Thursby-Pelham,
Fisheries Laboratory, Lowestoft.

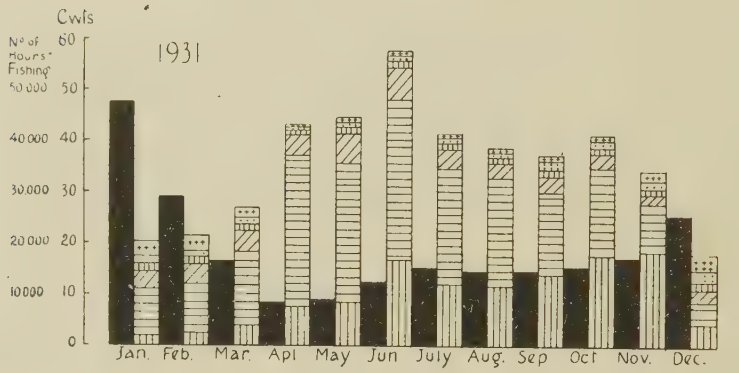
IT has been shown in many different publications that the stock of plaice has been declining in the more southerly part of the North Sea during recent years. The actual loss that this has entailed in the monetary return to the fishing industry has not been dealt with except in very general terms.

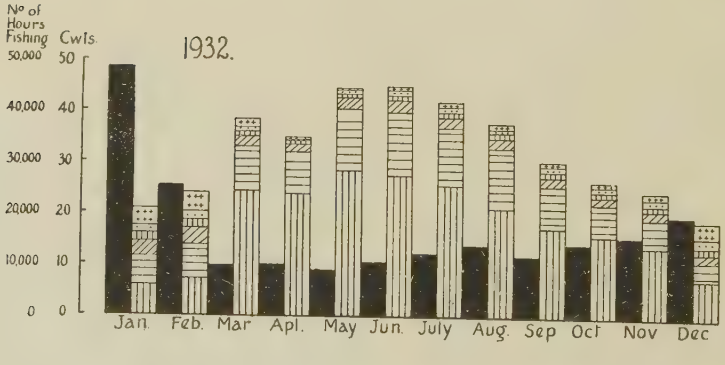
It is from the investigations made at Lowestoft that this decline has been most evident in the English North Sea fishing, and at this port, plaice form a high percentage of the financial turnover from the trawl fishery. Daily returns of the quantity (cwt.) landed of each trade category by steam trawlers and the average value per cwt., together with the number of hours fishing by these vessels, have been collected during the last six years; thus a very complete picture can be shown of the changes that have taken place from year to year in the value of the plaice landings. This is illustrated by the accompanying diagrams.

The prosperity of the industry depends mainly on three factors: a demand for the particular class of fish which is landed, a sufficient supply of such fish in the sea, and an adequate price for the fish. If all these are satisfactory trawling will increase, but if one or more fail the number of hours fishing will decline, as it will cease to bring in the necessary return for the heavy expenses involved. These facts explain some of the apparent anomalies in the diagrams.

Diagram 1. The total number of hours fishing in each month is shown by the black columns. Fishing is definitely seasonal, and is at its maximum from December to February, and falls sharply in March, April, and May, followed by a partial recovery from July onwards. The landings per 100 hours fishing of each trade category are shown by the different hatchings. The categories most in demand and therefore those which obtain the highest price (i. e., Best Medium, Small Medium, and Best Small) form a greater proportion of the plaice landed in January, February, and December than during the rest of the year. The actual total abundance of all categories combined is greatest in June and is followed in order of strength by either May or July. During these months Small and Dead Small are most plentiful. It is probable that if trawling was carried out on the same scale during


Cwts
1930
No of Hours Fishing
70
60
50
40
30
20
10
0
50,000
40,000
30,000
20,000
10,000
Jan
Feb
Mar.
Apl.
May
Jun
July
Aug.
Sep.
Oct.
Nov.
Dec.


Cwts
1931
No of Hours Fishing
60
50
40
30
20
10
0
50,000
40,000
30,000
20,000
10,000
Jan.
Feb.
Mar.
Apl
May
Jun
July
Aug.
Sep
Oct
Nov.
Dec.


No of Hours Fishing
Cwts.
1932.
50,000
40,000
30,000
20,000
10,000
0
50
40
30
20
10
0
Jan.
Feb.
Mar
Apl.
May
Jun.
July
Aug.
Sep
Oct
Nov
Dec

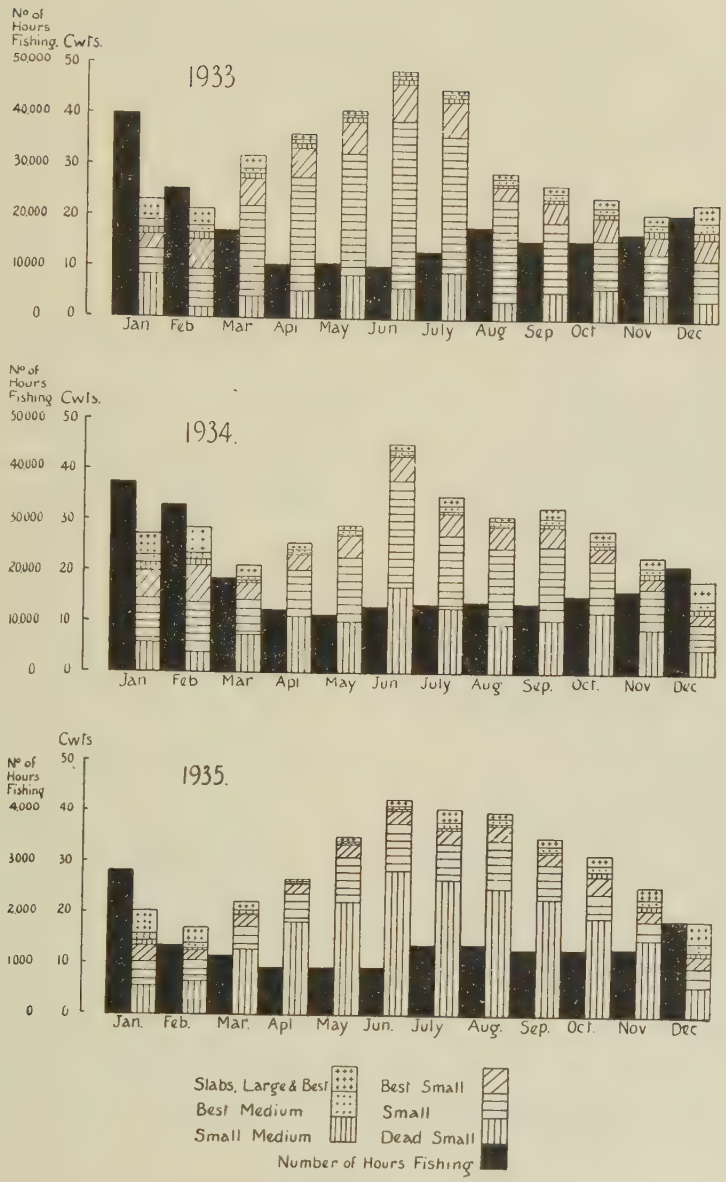


Diagram 1. Total number of hours fishing and landings (cwt.) per 100 hours fishing of each trade category of Plaice by Lowestoft steam trawlers for each month, 1930 to 1935.

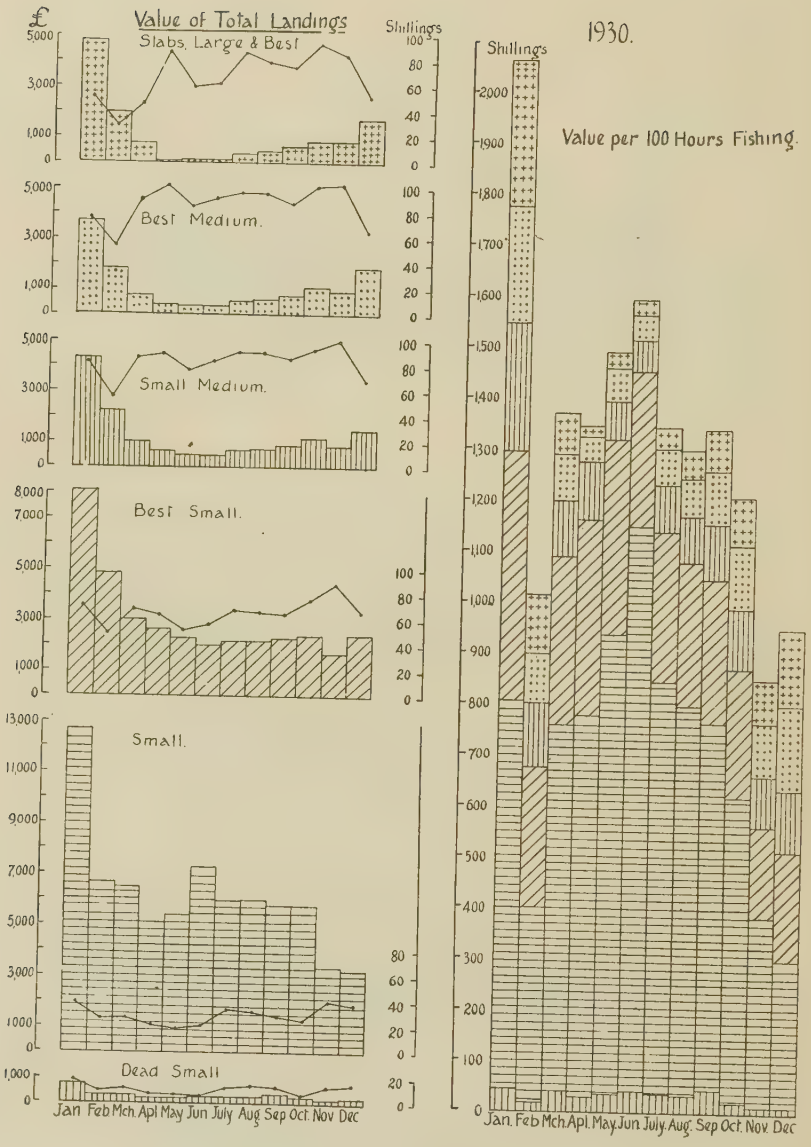


Diagram 2. 1930. Left side. Value of total landings of each trade category of Plaice (in pounds) and average value per cwt. in shillings. Right side. Value per 100 hours fishing of each trade category (shillings). Same key as in Diagram 1.

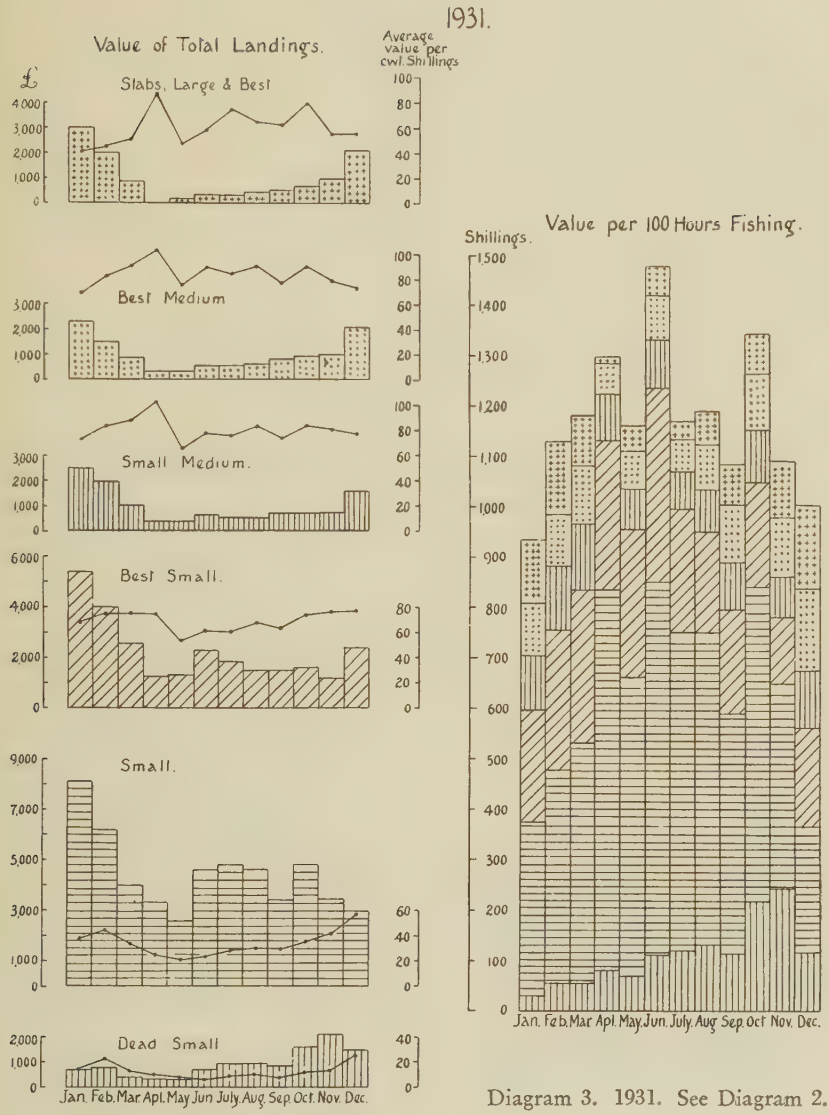


Diagram 3. 1931. See Diagram 2.

these months as in the winter, the supply of these small fish would exceed the demand and the price would fall; consequently fishing is limited. The abundance of the three most valuable categories showed a progressive decline until 1933 when the catch of Best Small rose considerably. This increase was due probably to the fastest growing fish of the 1928 brood being eligible for this category. However, the years 1934 and 1935 saw successive decreases of Best Small with the result that by the latter year the abundance of the three most valuable

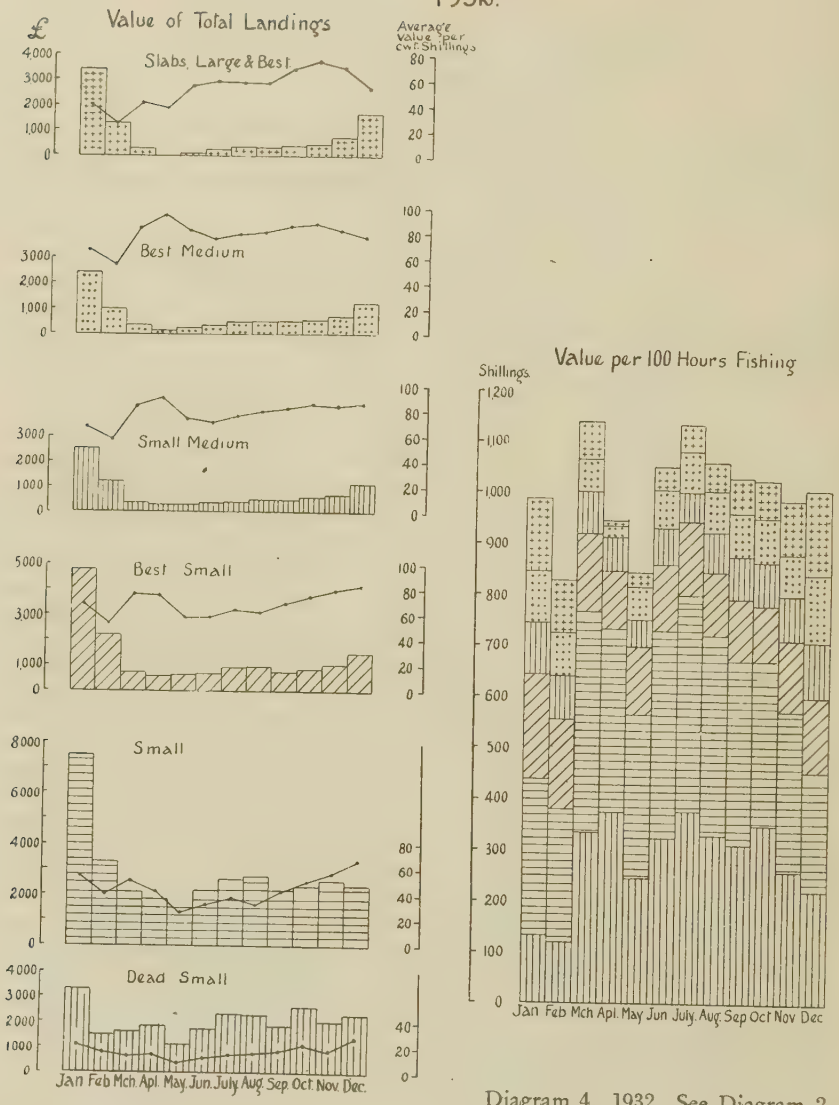


Diagram 4. 1932. See Diagram 2.

categories reached their lowest level. Concomitant with this state of affairs 1935 witnessed the smallest numbers of hours fishing by steam trawlers.

It will be noticed that the relative abundance of Small and Dead Small fluctuates widely. This can be attributed directly to the relative abundance of the different year-classes. Thus in 1932 Dead Small rose sharply when the rich 1928 year-class (IV-group) came into the

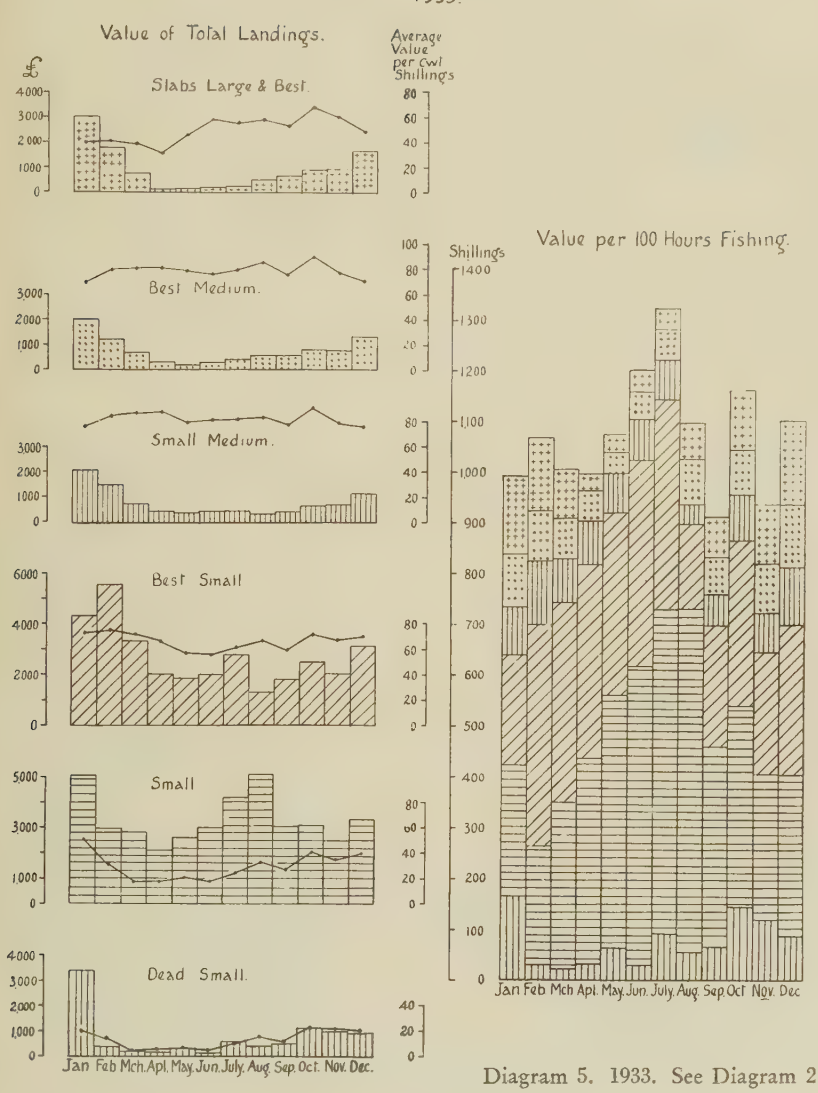


Diagram 5. 1933. See Diagram 2.

fishing; in the following year its great abundance was reflected in the Small category. Dead Small declined and remained low till 1935 when it rose again owing to the strength of the 1932 brood. The intervening year-classes were either below or barely of average strength.

Diagrams 2—7. The value in pounds of the total landings of each category is shown on the left-hand side, and superimposed on the histograms are graphs of the value per ctw. in shillings. On the

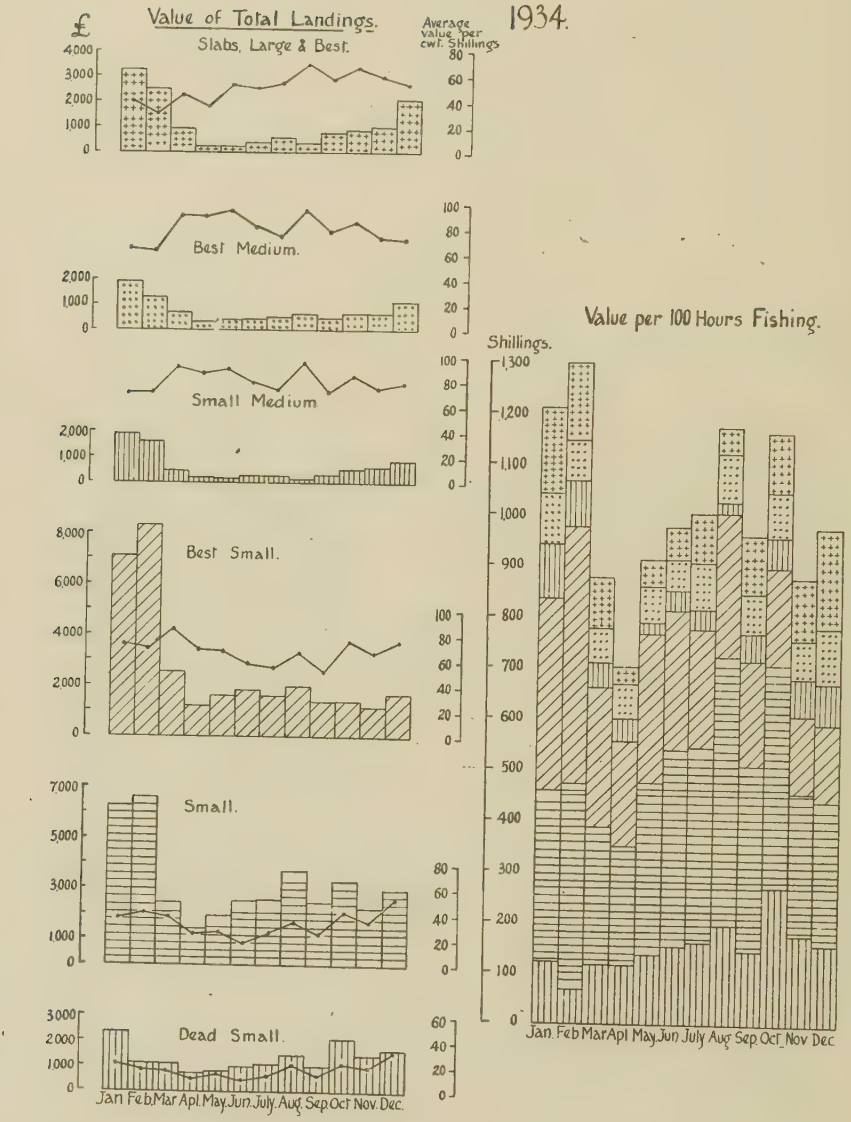


Diagram 6. 1934. See Diagram 2.

right hand, the value per 100 hours fishing in shillings is given. The total value of each category has fallen with the exception of Dead Small, and a very low level for the value of the total landings was reached in 1935 as compared with 1930.

1935.

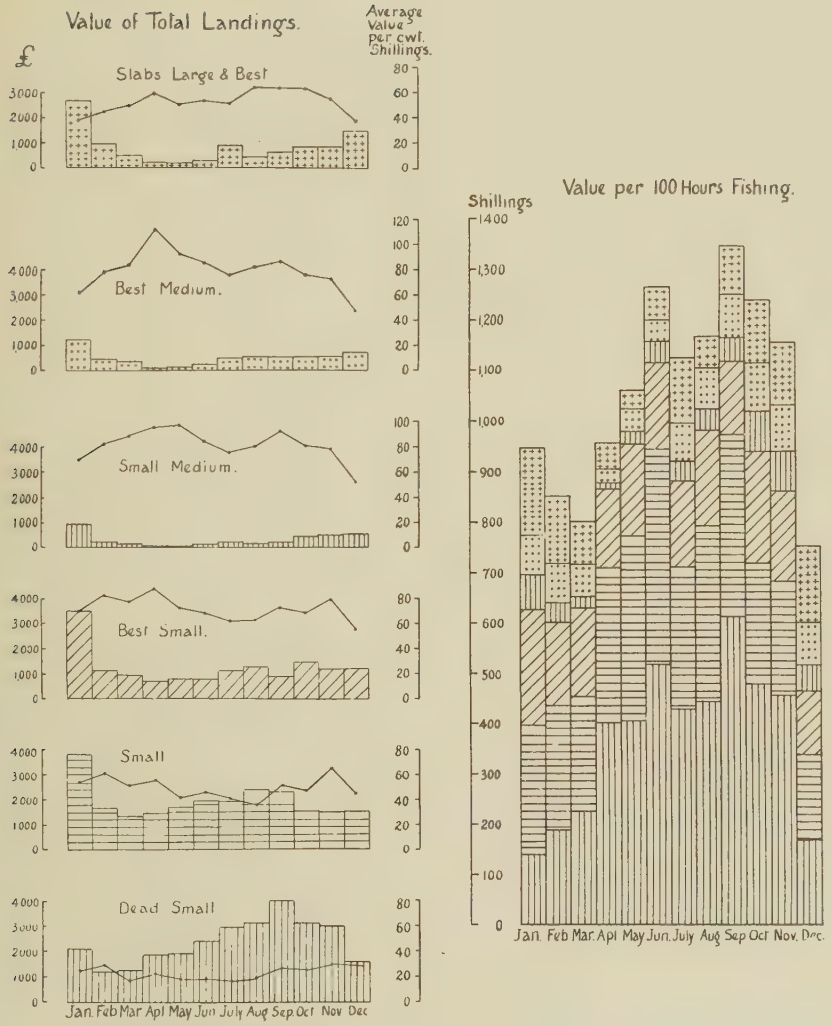


Diagram 7. 1935. See Diagram 2.

The prices per cwt. fluctuate from month to month. A comparison between the different years shows that Large, Best Medium, and Small Medium fetched a somewhat lower price in the last two years than they did in 1930 and 1931. On the other hand a comparison between

1935 and the previous years shows that Best Small fetched a somewhat higher price whilst Small and Dead Small rose considerably in value. Dead Small has risen steadily in value per cwt. since the minimum size limit was enforced in August 1933.

When the values per 100 hours fishing in the different years are compared, the decrease between 1930 and 1935 is so evident that no further words are needed. It would, however, have been very much greater if the value per cwt. of Small and Dead Small had not risen, in fact by approximately 73 and 98 per cent. respectively. It is obvious that the financial consequences of the decline in the stock have an extremely adverse effect both on the fishing industry and also on the consumer, who is having to pay more for an inferior article of food.

On the Mesh of Herring Drift-Nets in relation to the Condition Factor of the Fish.

By

G. P. Farran,

Department of Agriculture (Fisheries Branch), Dublin.

IT is well known to herring fishermen that, in order to get the best returns, the mesh of their nets must correspond to the size of the fish on the grounds, but that this correspondence must take account of both the length and the weight or condition of the fish has not, I think, been clearly pointed out.

I have tried in this paper to express in definite figures a relationship between the size of the mesh and the condition and length of the fish taken together.

The lower limit of capture by a net is obviously the smallest fish which cannot push its way through the meshes. It is difficult to ascertain this size experimentally, as we cannot, as in the case of a trawl, arrange a fine-meshed net to retain the escaping fish. It is possible by fishing a train of nets of different meshes to ascertain the size of the fish on the grounds, and by comparing the lower limits of capture of the various nets comprising the train to tabulate the proportions of each size respectively retained and allowed to escape by each net. It has been shown in this way[1]) that there is not an absolutely sharp division between the sizes retained and escaping, but that of fish below a certain size a larger and larger proportion of each successive length can escape. A purse seine might also be used to give a true sample of the stock on the grounds.

The upper limit of capture of a net is the largest fish that can push its head sufficiently far through the meshes to be retained. These large fish may be meshed by the maxillary bones, by the vertical ridges on the preopercle, and by the operculum. It seems probable that the proportion of fish caught by the maxilla is insignificant. As regards the preopercular ridges it is easy to shake a fish meshed by the head out of the net, and the practice of fishermen is to haul the net with

[1]) Hodgson. *a.* Journ. du Conseil II, 3, 1927.
b. "The Natural History of the Herring". 1934. (Buckland Lectures for 1933.).

the side on which the fish are mainly meshed uppermost, to avoid the loss of these fish which would drop out into the sea. The number of fish caught in this way is also probably a small proportion of those striking the net. A fish, however, that has pushed its head through a net till the mesh has passed the operculum is secured until it is forcibly removed.

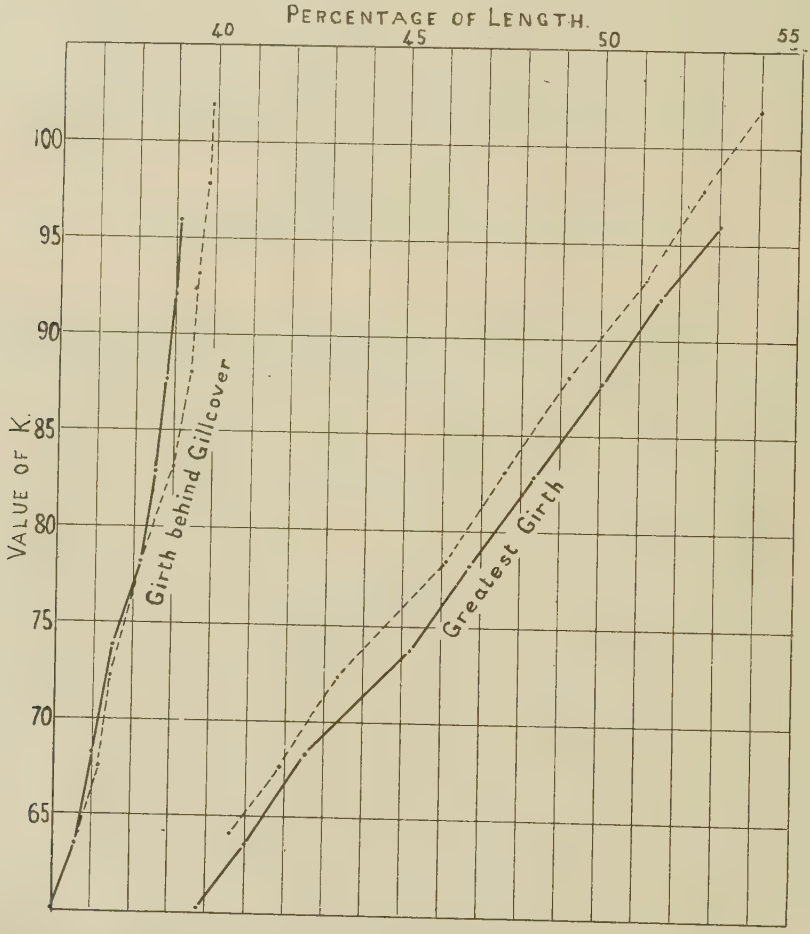


Figure 1. Girth behind gill cover and greatest girth shown as percentage of total length of fish of different condition (K) values.
Broken line, fish measured to vertical through tips of spread caudal fin.
Unbroken line, fish measured to tip of longest caudal ray.

The main range of sizes taken by a drift-net lies then, we may suppose, between these two limits, the smallest fish that cannot get through and the largest that can get its head through as far as the gill cover; and it was with a view to finding to what lengths this range would correspond for different values of K (i. e., 100 times the

weight in grammes divided by the cube of the length in centimetres) that the following measurements were made from time to time on a number of herrings; (a) length, (b) weight, (c) greatest girth, usually a short distance in front of the dorsal fin, (d) girth of head immediately behind the gill cover. The range of sizes measured was from 20 to 30 cm. and the condition from spent to spawning. The girth was measured by a piece of stout thread encircling the fish closely but not so closely as to constrict the body noticeably. Probably in actual practice the body of a meshed fish is definitely constricted but it would have been difficult to gauge the right amount of permissible tension if the thread had been allowed to constrict the body.

The fish were taken at various times in various localities round the coast of Ireland and were measured without regard to sex, so that the results give a general average which may not hold good in individual cases. The possibility of irregularities due to differences in the specific weights of male and female gonads has been ignored.

The length measurements were made in the first instance, as in Heincke's original method, to the vertical through the tips of the spread caudal fin, and the condition $K = \frac{100\,W}{l^3}$ of each fish calculated for this length. As the length measurement approved by the International Council (Lowestoft 1930) is to the tip of the longest caudal ray, bent up or down to the middle line, the equivalent value of K for the length thus expressed has been calculated on the assumption that the international measurement is longer than that of Heincke by 5 %, a figure which numerous duplicate measurements have shown to be reasonably accurate, and these revised values of l and K have been used throughout the paper except where otherwise stated.

In the two following tables are given the results of measurement of 235 fish arranged according to successive values of K, (a) the original figures based on the measurement to the tips of the spread caudal, (b) the equivalent values when the fish are measured to the tip of the longest caudal fin ray. The figures in brackets are the number of fish examined in each K group.

Table I.

(a) Herring measured to vertical through tips of spread caudal.

Range of K	Average K	Greatest girth, % of length	Girth behind operculum, % of length
101 — 105	101.9	54.0 (11)	39.9 (11)
96 — 100	97.8	52.6 (22)	39.8 (22)
91 — 95	93.1	51.2 (24)	39.6 (24)
86 — 90	88.0	49.2 (26)	39.4 (25)
81 — 85	83.1	47.6 (38)	39.0 (37)
76 — 80	78.4	46.1 (30)	38.2 (28)
71 — 75	72.3	43.3 (26)	37.7 (27)
66 — 70	67.6	41.8 (41)	37.2 (42)
61 — 65	64.1	40.6 (15)	36.7 (15)

Table II.

(b) Herrings measured to tip of longest caudal ray.

Average K	Greatest girth, % of length	Girth behind operculum, % of length
96	53.0	39.1
92.1	51.5	39.0
87.7	50.1	38.8
82.9	48.3	38.6
78.2	46.7	38.2
73.9	45.2	37.5
68.3	42.5	37.0
63.6	41.0	36.5
60.3	39.8	36.0

These figures are shown as a graph in Fig. 1.

Table III.

Upper Limits of Capture.

Rows to yard	Circ. of mesh cm	% of L / K	36.7 / 65	37.2 / 70	37.7 / 75	38.2 / 80	38.7 / 85	38.9 / 90	39.1 / 95	39.2 / 100	39.2[1] / 105
30	12.19		33.20	32.78	32.35	31.85	31.48	31.34	31.18	31.10	31.10
31	11.80		32.14	31.71	31.30	30.85	30.48	30.33	30.18	30.10	30.10
32	11.43		31.13	30.73	30.31	29.88	29.53	29.38	29.24	29.16	29.16
33	11.08		30.17	29.78	29.38	28.97	28.65	28.47	28.35	28.28	28.28
34	10.76		29.30	28.94	28.54	28.12	27.80	27.64	27.50	27.44	27.44
35	10.45		28.46	28.09	27.70	27.30	26.99	26.85	26.73	26.66	26.66
36	10.16		27.66	27.31	26.94	26.56	26.25	26.12	25.99	25.92	25.92
37	9.89		26.95	26.58	26.23	25.85	25.55	25.40	25.30	25.24	25.24
38	9.63		26.23	25.88	25.53	25.17	24.88	24.74	24.63	24.57	24.57
39	9.38		25.54	25.22	24.88	24.52	24.23	24.11	24.00	23.93	23.93
40	9.14		24.90	24.58	24.24	23.90	23.61	23.49	23.38	23.32	23.32
41	8.92		24.28	23.97	23.65	23.30	23.02	22.90	22.81	22.74	22.74
48	7.63		20.77	20.50	20.22	19.94	19.71	19.60	19.51	19.46	19.46

Table IV.

Lower Limits of Capture.

Rows to yard.	Circ. of mesh cm.	% of L / K =	41.5 / 65	43.4 / 70	45.6 / 75	47.4 / 80	49.2 / 85	50.8 / 90	52.6 / 95	54.3 / 100	56.1[1] / 105
30	12.19		29.38	28.10	26.75	25.70	24.78	24.02	23.17	22.46	21.73
31	11.80		28.44	27.20	25.90	24.87	23.99	23.34	22.42	21.74	21.04
32	11.43		27.55	26.34	25.08	24.10	23.24	22.52	21.71	21.06	20.37
33	11.08		26.70	25.53	24.30	23.36	22.52	21.81	21.05	20.42	19.75
34	10.76		25.92	24.77	23.60	22.69	21.86	21.17	20.43	19.83	19.18
35	10.45		25.70	24.08	22.92	22.04	21.24	20.57	19.86	19.25	18.63
36	10.16		24.49	23.42	22.28	21.42	20.65	20.02	19.31	18.73	18.11
37	9.89		23.82	22.78	21.67	20.85	20.10	19.47	18.79	18.22	17.64
38	9.63		23.19	22.18	21.12	20.30	19.57	18.97	18.30	17.74	17.17
39	9.38		22.61	21.62	20.58	19.77	19.08	18.47	17.83	17.29	16.73
40	9.14		22.04	21.06	20.04	19.23	18.58	18.01	17.37	16.84	16.29
41	8.92		21.49	20.53	19.59	18.79	18.13	17.56	16.95	16.43	15.09
48	7.63		18.37	17.57	16.73	16.08	15.51	15.02	14.49	14.00	13.60

[1]) By extrapolation.

It will be seen from these tables that while the greatest girth of a fish may vary from about 40 to 53 per cent. of its length according to whether it is a spent or full fish corresponding to values of K of from 60 to 100, ripe males being usually heavier than females of the same length, the girth behind the gills shows a much smaller but appreciable range of 36 to 39 per cent.

As an illustration of the implication of these measurements, taking for instance a fish of a length of 25 cm., they show that in good condition, K = 95, the girth behind the gills will be 39.0 per cent. of the length, i.e. 9.5 cm., and the greatest girth 52.5 per cent., or 13.1 cm., but in poor condition, K = 65, the corresponding girths will be 36.7 per cent. and 41.5 per cent., or 9.2 cm. and 10.4 cm., which means that a fish in poor condition will go easily through a net which is well adapted to its capture when a full fish.

Considering the question in relation to the mesh of the net and assuming, as suggested above, that the girth behind the gills and the greatest girth represent the effective limits of capture, we find, to take an example, that a mesh of internal circumference of 10 cm., or approximately 36 rows to the yard, will take fish of between 19.0 cm. and 25.5 cm. in length if they are in good condition with K = 95, but if they are very thin, with K = 65, the range of sizes will be from 24.1 cm. to 27.2 cm. This relationship is shown in Tables III and IV, which give the upper and lower limits of capture, i.e., the lengths of the largest fish which would be meshed behind the gill cover and the smallest which would be meshed round the body, for nets with from 30 to 41 rows of meshes to the yard and for values of K from 65 to 105.

In these tables the percentages corresponding to the values of K are taken without correction from the graph, Fig. 1, given above. Also no allowance is made for the thickness of the twine in calculating the internal measurement of the mesh from the number of rows to the yard, i.e., the internal circumference of the mesh of a net of 36 rows to the yard is taken to be 4 inches or 10.16 cm.

In reality the size of the mesh must necessarily be smaller than the dimensions given in the table, probably by from 2 to 5 per cent. according to the thickness of the twine and whether it is barked or tarred. To get some idea of what the limits would be, rough measurements were made of three nets, two new barked nets of fine cotton and one old net heavily tarred.

A new net of barked cotton stretched by hand without excessive straining "on the diamond", i. e. with the meshes closed, gave 30½ rows to the yard. The internal diagonals of 30 meshes of this net, stretched between a fixed point and the point of a lead pencil, gave the following measurements: —

mm.	57	58	59	60
No.	1	3	15	11

Average: 59.20 mm.

The stretched diagonal without allowance for thickness of twine is 59.96 mm., which gives a difference of .76 mm. or 1.27 per cent.

An old net, heavily tarred and stiff, stretched as above, gave 31.5 rows to the yard and the measurements of 30 meshes were

mm.	53	54	55	56
No.	3	16	10	1

Average: 54.30 mm.
Average without allowance for thread: 58.06.
Difference: 3.76 mm. or 6.48 %.

A third net of barked cotton, unused, measuring, when stretched by hand as above, 32.5 rows to the yard, gave a range of sizes for 30 meshes

mm.	52	53	54	55	56	57
No.	2	2	1	11	13	1

Average: 55.13.
Average without allowance for thread: 56.20.
Difference: 1.07 mm. or 1.92 %.

These measurements besides giving an approximate indication of the actual size of the mesh also show what variation in size may occur in any one net.

This variation, as might be expected in a machine-made net, is comparatively small, too small to account to any great extent for the graduation in size of the fish escaping the net, though it may play a small part in this. In actual practice, as well known, there is not a sharp selection by the net in cases where it is clear that the mesh of the net is a limiting factor, but the division between the escaping fish and those retained is graduated over a wide range either at the upper or lower limits of capture by the net. If variation in the size of the mesh is rejected as an explanation of this graduation we may consider whether variation in the value of K may not be of importance in causing it.

Taking three examples from drift-net catches on the Irish coast and discarding the extremes, both large and small fish, which may have been subject to selection, the range of K is found to be considerable.

K	No.	%	
(a) Kinsale; 8th May 1928.			
65	3	2.8	
70	21	19.6	Length: 26.5 — 29.6 cm.
75	47	44.0	Mainly recovering spents
80	30	28.0	in stage VII — II.
85	6	5.6	

K	No.	%	
(b) Howth; 26th June 1928.			
75	1	1.4	
80	3	4.3	
85	22	31.4	Length: 25.5 — 27.5 cm.
90	27	38.5	Mainly stages II and III.
95	15	21.4	
100	2	2.9	
(c) Howth; 30th July 1930.			
80	4	5.8	
85	15	21.7	
90	23	33.3	Length: 24.5 — 26.5 cm.
95	18	26.1	Stages II to V, mainly III.
100	6	8.7	
105	3	4.4	

These examples, taken at random, are representative of the normal variation of K in almost every case where its values have been worked out in Irish samples. Small errors due to *post mortem* shrinkage of the fish and to inevitable inaccuracies in weighing and measuring will have made the range appear a little wider than it is in reality. A difference of 1 mm. in the length of a fish is equivalent to 1.5 in the value of K in a small fish of 20 cm. and 1.0 in a large one of 30 cm. Direct measurements of the mesh of the nets by which the samples were taken were not made, so that it is necessary to take the best evidence available. Measurement of the girth of the fish where they are clearly marked by the net gives an indication of the mesh, not very satisfactory but probably often nearer than the fisherman's own estimate, which often differs widely from the size as shown by direct measurement, e. g., a net described to me as 36 rows to the yard has been found to measure 41 rows.

The Kinsale sample of 8th May 1928 was said to have been taken with nets of 31—32 meshes to the yard. Assuming that the net was of 31 rows, with an internal circumference of 11.80 cm., theoretically the catch in a uniform shoal with equal numbers of all sizes of fish would have been —

K 65	2.8	per	cent.	between	28.44	and	32.14	cm.
70	19.6	„	„	„	27.20	„	31.71	„
75	44.0	„	„	„	25.90	„	31.30	„
80	28.0	„	„	„	24.87	„	30.85	„
85	5.6	„	„	„	23.99	„	30.48	„

Actually, the catch was just within these limits, the percentage composition being

cm.	24	25	26	27	28	29	30	31	32
%	.5	5.6	6.6	17.2	15.2	21.7	24.3	8.2	.5

This is shown in the graph (Fig. 2) where the highest point of the graph of the actual catch is made equal to 100 on the graph of the theoretical catch. It seems probable that in this case both the upper and lower limits of the catch were affected, if not determined, by the mesh of the net.

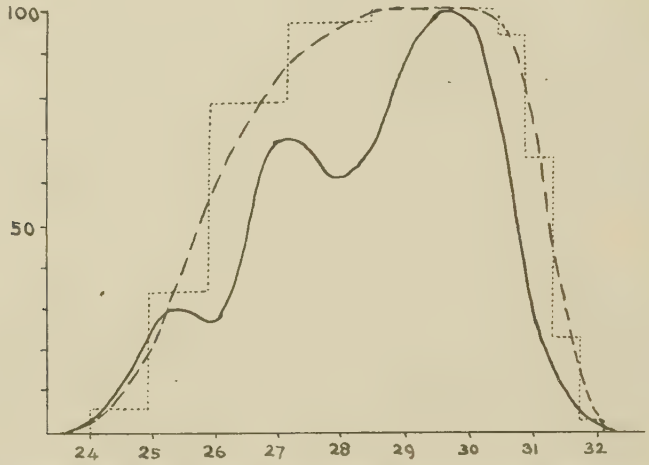


Figure 2. Kinsale, 8th May 1928. The broken line shows the theoretical limits of capture, the unbroken line the actual catch.

In the second example, Howth, 26th June 1928, the mesh of the net was not stated but measurements of the circumference of the fish, where they were marked by the net, indicated that the mesh probably had an average internal measurement of 10.7 cm. Taking this as 34 rows to the yard, or an internal circumference of 10.76 cm., the theoretical catch of the net would have been —

K 75	1.4	per cent.	between	23.60	and	28.54	cm.
80	4.3	„	„	„	22.69	„	28.19	„
85	31.4	„	„	„	21.86	„	27.80	„
90	38.5	„	„	„	21.17	„	27.64	„
95	21.4	„	„	„	20.45	„	27.50	„
100	2.9	„	„	„	19.83	„	27.45	„

Actually the catch was —

cm.	22	23	24	25	26	27	28	29
%	.6	2.5	16.0	29.0	28.4	18.4	4.9	3.1

In this case again the actual catch was within the theoretical limits except for a small residue, ca. 3 %, of large fish which were probably meshed by the maxilla or preopercular ridges. This is shown in the graph (Fig. 3). In this case there were apparently no smaller fish present than those actually taken.

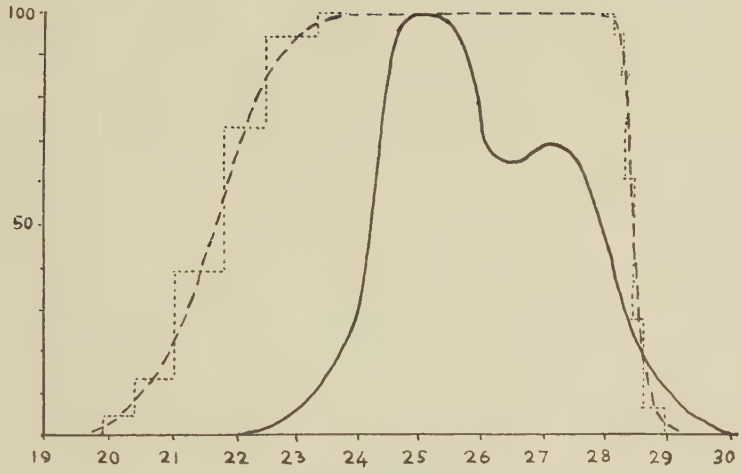


Figure 3. Howth, 26th June 1928.

In the third sample, (Fig. 4), Howth, 30th July 1930, the mesh of the nets was said to have been 30—31 rows to the yard but this was probably incorrect, though it may have been the original mesh when new, since measurement of the net-marked fish gave an average mesh of 10.99 cm. Taking this as 33 rows, the nearest whole number, or 11.08 cm. circumference, we get the theoretical limits of —

K 80	5.8	per	cent.	between	23.36	and	28.97	cm.
85	21.7	„	„	„	22.52	„	28.65	„
90	33.3	„	„	„	21.81	„	28.47	„
95	26.1	„	„	„	21.05	„	28.35	„
100	8.7	„	„	„	20.42	„	28.28	„
105	4.4	„	„	„	19.90	„	28.23	„

The composition of the actual catch was —

cm.	23	24	25	26	27	28	29	30
%	1.5	8.9	30.4	20.7	20.0	14.8	3.7	.4

The distribution of this within the limits is very similar to that of the previous Howth sample.

Though these examples do not prove the reliability of the measurements here put forward, they are not inconsistent with them; but to determine how far the figures set out in these tables and graphs will hold good in actual practice, extended experiments will be needed, made with carefully measured nets of definite mesh, the catch of each net being weighed individually as well as measured.

Hodgson[1]) has published some records of catches made in the course of two experiments with measured nets on the east coast of

[1]) l. c.

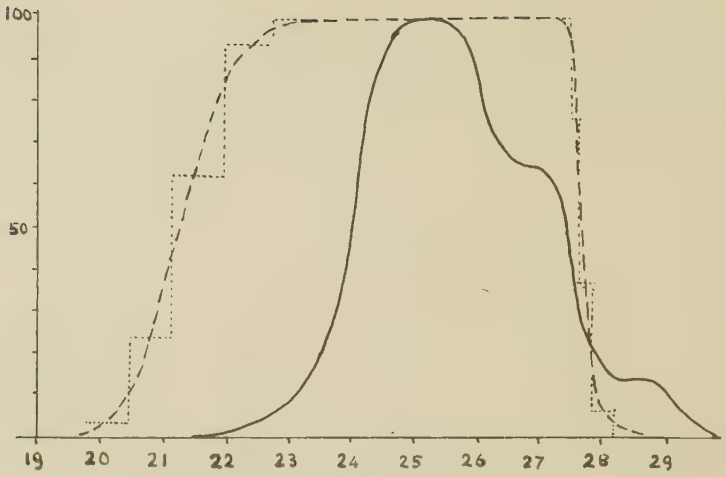


Figure 4. Howth, 30th July 1930.

England, but since particulars by which the value of K could be determined are not given, these experiments cannot be used as a definite test. It would seem, however, that most of his results can be brought within the scheme by selecting an appropriate value of K, but not all, for on two occasions, with a net of 48 rows in the first experiment and with a net of 35 rows in the second experiment, the sizes of the fish taken were larger than could have been accounted for by any possible value of K. On the first occasion this is explained by the comment of Buchanan-Wollaston[1]) on the experiment when he says that almost all the fish were caught by the nose, and possibly the same explanation may apply in the second case. Fish caught in this manner have been deliberately omitted from the measurements which I made.

Summary.

Measurements of the greatest girth of herrings and the girth behind the gill cover have shown that the girth is proportional to the condition factor, K, of the fish.

It follows from this that the catching power of a net is dependent on the condition of the fish as well as on the length.

An attempt is made in the paper to express in figures the relationship between the length and K of the fish caught and the circumference of the mesh, based on the observation that the greatest girth ranges from 41.5 % of l when $K = 65$ to 54.3 % of l when $K = 100$ and the girth behind the gill cover from 36.7 % to 39.2 % of l for the same values of K.

[1]) Journ. du Conseil II, 3. 1927.

On the Diurnal Variation of Size-Groups of Trawl-Caught Herring.

By

C. E. Lucas,

Department of Oceanography, University College, Hull.

IN the course of investigating the relationship between catches of trawl-caught herring and the plankton, the diurnal variation in the quantity of the catch was brought into prominence. This feature was commented upon in the early days of herring trawling by H j o r t (1912) as follows: "Recently it has proved possible to trawl successfully for herring along the sea bottom, but only in the daytime." Herring are now also trawled by night, but there is some (at times considerable) variation in the proportion of night and day catches, the day catches being usually the heavier. This variation has been reviewed briefly by E h r e n b a u m (1925).

Since the herring may be considered to be on or very near the bottom when caught with the trawl, it appears evident that when the day catches are the larger, at night a certain (probably varying) proportion of the fish migrate from the waters fished by the trawl and rise nearer the surface. The writer wondered whether it would be possible to show that the rise is characteristic of one type of fish more than another, but in order to test this possibility samples of herring from catches made at different times of the day and night would need to be analysed for various characters. This was not possible at the time, but fortunately some evidence was available in a report by F u l t o n on herring trawling during 1913 (F u l t o n 1922) although it appears to have received little or no attention at the time.

This report was the result of an investigation into the alleged harmful effects of herring trawling (comparatively a new fishery in the pre-war years) upon the stocks of young herring and the immature classes of other food fishes. Samples of herring caught by commercial trawlers in the usual course of fishing and also by the R. S. "Goldseeker" were measured and examined for maturity conditions; details of the dates of capture, times of shooting, and observations of the

Table I.

Table of the data derived from Fulton's Table 1. (Fulton, 1922). [1])

	Name of boat and No. of Cruise.	Av. size of fish, cm.	Average Catch per hour in Baskets. Large Fish Day	Twilt.	Night	Ratio Day/Night	Small Fish Day	Twilt.	Night	Ratio Day/Night	Total Day	Twilt.	Night	Percentage Large Fish for each voyage. Day	Twilt.	Night
Voyage Group A.	"T. W. Irving" I. ..	20.5	2.1	3.4	3.8	0.6	4.9	1.3	0.8	6.1	7.0	4.7	4.6	30	73	81
	"Vale of Clyde", III.	21.0	2.3	1.7	1.0	2.3	6.2	0.7	0.3	20.7	8.5	2.4	1.3	27	69	77
	"T. W. Irving" II. ..	21.2	4.8	3.8	3.2	1.5	3.8	2.0	0.5	7.6	8.6	5.8	3.7	56	66	86
	"William Wetherley" .	22.9	2.3	0.8	1.0	2.3	1.6	0.6	0.4	4.0	3.9	1.4	1.4	60	64	71
Voyage Group B.	"Vale of Endrick" III.	23.2	2.0	3.4	0.6	3.3	1.4	2.8	0.3	4.7	3.4	6.2	0.9	57	54	81
	"Margaret Wetherley".	23.7	1.1	5.6	2.8	0.4	1.0	0.9	0.9	1.1	2.1	6.5	3.7	55	86	75
	"North Star" I.	24.2	6.7	1.6	—	—	0.0	0.0	—	—	6.7	1.6	—	100	100	—
	"North Star" II.	24.4	3.2	0.6	0.6	5.3	1.6	0.0	0.5	3.2	4.8	0.6	1.1	67	100	52
	"Vale of Clyde" I. ..	24.5	8.2	4.0	0.57	14.3	1.8	0.3	0.04	45.0	10.0	4.3	0.61	82	92	94
	"Vale of Clyde" II. .	26.4	3.2	2.1	3.0	1.1	0.5	0.4	0.3	1.7	3.7	2.5	3.3	87	84	90
	"T. W. Irving" III. .	?	1.2	0.0	0.46	2.6	0.2	—	0.04	5.0	1.4	—	0.5	87	—	92

[1]) The total catches do not necessarily agree with Fulton's totals for the respective voyages since only those hauls have been considered which showed the catches of large and small fish. The columns headed day/night show the ratio of day to night catches for the large and small fish of each voyage. There is no information concerning the average size of the herring caught by the "T. W. Irving" in her third cruise, but the proportion of large fish caught during the daytime suggests, when compared with the results of the other boats, that the average would be nearer that of voyage group B than voyage group A.

weather conditions were also made. In particular there are in Fulton's Table 1 (Fulton, 1922), among other data relevant to the points then being investigated, details of the quantities of large and small herring caught at different times of the day during eleven voyages of commercial vessels in September and October 1913. It is not clear whether this classification of the catches into large and small fish is the work of the officials of the Scottish Fishery Board (who certainly did measure large numbers of fish), or whether the data were obtained from the fishermen, but both sizes are termed marketable

herring and do not include the very small fish which were rejected from the catches and thrown back into the sea.

The frequency distribution of the sizes of herring as shown for those caught in the commercial vessels and also by the R. S. "Goldseeker" showed two modes, one at 21 cm. and one at 25 cm. Fulton separated the voyages into group A, in which the bulk of the herring were small (giving average sizes of 20.5 to 22.9 cm. per voyage), and group B in which the bulk of the herring were larger (giving average sizes of 23.2 to 26.4 cm. per voyage). In the A voyages "the fishery was mainly conducted in the grounds lying between the south end of the Gut and the northern edge of the Dogger Bank," whilst in the B voyages in which the herring were as a whole larger, "the fishing was principally on the western edge of the Dogger Bank on the grounds known as Brucey's Garden." This association of the spatial distribution of the voyages with the size of the fish was not exact; in some of the voyages there was overlapping between the two areas and in others an extension of fishing beyond the region mentioned. In Table I are shown the average sizes of the herrings taken in the various voyages (column 2). Examination of the states of maturity of the herrings suggests that the fish of the A voyages were probably mainly immature whilst those of the B voyages were about 50 % full with some even spent; the analyses of the states of maturity of herring collected by the R. S. "Goldseeker" on the same grounds at the same time, show fish of all stages from "less than ¼ full" to "spent", the average size of the former group being about 21 cm. whilst that of the fish from ¾ full to spent was 24—27 cm.

In the report the catches are divided into day, twilight, and night hauls. From the data given it is possible to estimate the proportions of large and small fish taken on each of the voyages for each of these sections of the day; these are shown in Table I. It can be seen from the results that the percentage of large fish caught during the day is appreciably less than that at night in nine out of the eleven voyages supplying the information. The two exceptions are the two voyages of the "North Star", when during the first there were no night catches (and all the herrings were recorded as large), and during the second only three night catches were made, and these were at the end of the voyage when all the catches showed an appreciable drop in quantity (hence the night catches would not be weighted as heavily as they should be in relation to the daytime ones). The twilight catches were mainly intermediate. Where the catches were composed mainly of large herring, as in the B voyages, there obviously cannot be much variation, but such as is shown is in agreement with the marked variations shown by the catches in the A voyages where more small herrings were evident.

The diurnal variation can be shown in another way if for each of the voyage groups A and B the proportion of large fish in the catch per hour is plotted against the time in three-hourly periods throughout the day. The following percentages are obtained and the variation is shown graphically in Fig. 1.

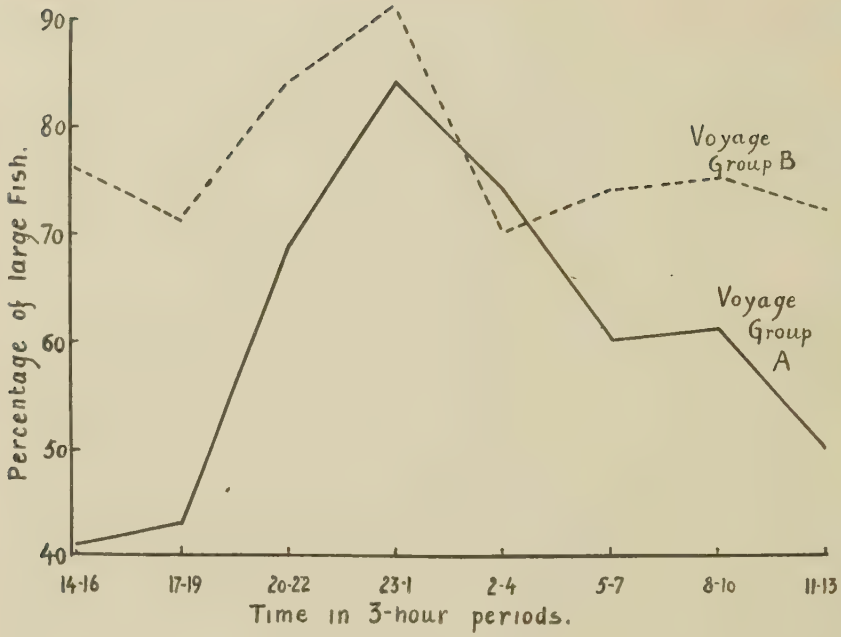


Fig. 1. Graph showing the diurnal variation in the proportion of large herring in the catches of two groups of voyages in 1913 (compiled from the data in Fulton's report, 1922). The proportion of large fish in the catch is plotted against the time in 3-hour periods. Group A consisted mainly of smaller fish and Group B mainly of larger ones.

Period in hours (inclusive) ...	11—13	14—16	17—19	20—22	23—1	2—4	5—7	8—10
Percentage large fish. Voyage group A.	50	41	43	69	84	74	60	61
[1])Percentage large fish. Voyage group B.	72	76	71	84	91	70	74	75

[1]) Excluding the first voyage of the "North Star" where no night catches were obtained and all the herring were classified as large.

We see that the proportion of large fish increases towards midnight and decreases towards midday, although the process is more regular and more extensive in the fish of the A voyages than with those of the B voyages. Similar graphs can be made for each voyage, but necessarily these are not so regular owing to the relative paucity of data. The graphs obtained from the three cruises of the "Thomas W. Irving", the first and third cruises of the "Vale of Clyde", the third cruise of the "Vale of Endrick", and the cruise of the "Margaret Wetherley" illustrate the principle well or fairly well, whilst those of the "William Wetherley", the second cruise of the "Vale of Clyde"

Table II.

Table of the average catch (in baskets) per hour throughout the day in three-hour periods during the years 1931—33 by a Hull herring trawler.

Time in 3-hour periods.	23—1	2—4	5—7	8—10	11—13	14—16	17—19	20—22
1931	6.0	8.5	12.5	25.6	39.6	28.3	20.0	11.8
1932	13.3	17.8	11.2	16.2	21.8	17.3	18.0	14.9
1933	6.4	9.5	13.6	17.4	17.5	27.8	25.7	9.4
1931—3	8.6	11.9	12.4	19.7	26.3	24.5	21.2	12.0

and the second of the "North Star" are irregular: the first cruise of the "North Star", as mentioned before, showed large fish from all the catches.

These results have at least two points of interest. Hjort and Ehrenbaum have demonstrated and discussed the diurnal variation in the size of trawled herring catches. In the report by Fulton, it is shown (Fulton, loc. cit. p. 47) that the average catch for ten boats per hour during the day was 4.9 baskets, in the twilight 3.3 baskets, and at night 2.3 baskets. Similar results have been found in this department in an analysis of the catches of a Hull herring trawler during 1931—33, the average size of the catches being usually larger towards midday and smaller towards midnight. (Table II shows the average catch per hour made by this boat during these three years: I am indebted to the captain of the trawler for his permission to use this information.) One must deduce from these diurnal variations that when the day catches are the higher, a proportion of the herring are leaving the bottom towards night and returning in the daytime. The re-examination of Fulton's data suggests this migration to be due in part at least to the migration from the bottom of the smaller herring at nighttime. The actual quantity of large herring remains relatively constant, though columns 3 to 5 of Table I show that there is a tendency for even this quantity to be a little larger during the day than during the night. Columns 6 and 10 of Table I show the ratio of day to night catches for the large and small herring in each of the voyages. In the A voyages the average ratio of day to night catches is 1.7 for the large fish and 9.6 for the small fish catches: in the B voyages these figures are 4.5 and 10.1 respectively. It appears that about 90 % of the small fish leave the bottom at night. The tendency for the large fish also to be rather more abundant during the day than at night might be explained if the classification into large and small herring does not effectively distinguish the vertically migrating fish from those which tend to remain on the bottom, e.g., it might be fish of different stages of maturity which migrate differentially.[1]

[1]) From the evidence given on the relation between the size of the fish and the related maturity classes, it may be that we can substitute the term unripe fish for small fish. In Fulton's report there is some evidence to suggest that full, spawning, or spent fish are to be found in higher proportion in the night catches than in those by day, but this information is very scanty.

Table III.

Table of the proportions of large herring for each voyage under (1) bright or sunny conditions and (2) rain, fog, haze, cloud, or otherwise not bright sky.

Boat and No. of voyage.	No. of hauls providing data.		Percentage of large herring in the total hauls when	
	Bright	Dull.	Bright.	Dull.
"T. W. Irving" I.	9	6	27	29
"Vale of Clyde" III.	8	10	27	28
"T. W. Irving" II.	4	11	44	64
"William Wetherley"	5	6	55	66
"Vale of Endrick" III.	4	3	61	59
"Margaret Wetherley"	8	5	45	64
"North Star" I.	4	4	100	100
"North Star" II.	1	6	100	68
"Vale of Clyde" I.	12	6	80	91
"Vale of Clyde" II.	8	10	89	86
"T. W. Irving" III.	2	1	89	86

The occurrence of such a daily migration suggests the possibility of the intensity of illumination being linked with the process. Whilst such a relationship can at present only remain a hypothesis (which has been to some extent discussed by E h r e n b a u m) there is some further evidence in its favour. The daytime catches for each voyage have been divided into two sets in which the weather conditions were respectively (1) "Bright" or "Sunny" and (2) direct sunlight was absent, i.e. haze, clouds, rain, or fog prevailed. When the proportions of large fish were found for each set, we see that on the whole, in sunny weather the percentage is less than when there is no direct sunshine (see Table III). This suggests that the small herrings may be higher in the water under conditions of increasing darkness and that they move to the bottom in bright sunlight. If these data are divided as before into two voyage groups of mainly small and mainly large herring (previously discussed on p. 55), we find that in the voyage group A 50 % of the total catches are large fish when the sun is obscured by day as opposed to 35 % when the weather is sunny: in the voyage group B the proportion is 80 % under both conditions. This difference is understandable when we consider the relatively slight differences in illumation and the fact that in the B voyages the population was composed mainly of large fish and only slight differences were found in their proportions in the day and night catches. It must be borne in mind that even if this light relationship should be confirmed by further testing, the effect of the light may not be direct: the small (and possibly immature) herring may have been moving in relation to the vertical distribution and migrations of the plankton: investigations made from this department on the Fladen herring grounds in the years 1932—35 indicate the plankton to have been sparse at the bottom though much more abundant nearer the surface. Again, the movement may be correlated with some other cause at present not appreciated.

A second point of interest in connexion with this suggested diurnal size-variation lies in its relationship to the statistical analysis of the herring stocks. From the ecological viewpoint, the distinction between the commercial landings of a food fish and the "stock" of that fish cannot be too heavily stressed (Ford, 1928). The evidence given here suggests that in a stock of herring containing different size-groups there may well be a continuous diurnal variation in the constitution of the trawl catches. From 30 to 50 % of the catches (those at night) may show a lower proportion of small herring than during the day. This difference might at times be very pronounced and the average constitution of the catches so obtained might have an appreciable and variable difference from that of the stock. Further, relations between the trawled herring and the drift herring now being investigated (see e.g. Wood, 1935) suggest that it is not impossible that the analysis of the constitution of the drift catches may be similarly affected.

The writer in publishing these preliminary findings hopes that they may be checked by other workers from more extensive material.

Summary.

It has previously been shown that usually trawled herring catches are larger by *day* than by night. A further example of this diurnal variation is shown. From a re-examination of the data given in Fulton's report on herring trawling (1922) it is shown that the proportion of *large* herring in the catches is greater by *night* than by day, or in other words, the diurnal variation of the total catches may be due to an upwards migration of the herring at night which is more extensive in the *small* (and possibly immature) herring than in the larger ones. It is suggested that this vertical migration may be linked with that of the plankton *via* change in illumination. The possible effects of such a differential migration (if confirmed) upon the statistical estimates of herring stocks is discussed.

References.

Ehrenbaum, E., 1925. "Untersuchungen über den Trawlhering", Berichte der deutschen wissenschaft. Kommission für Meeresforsch. N. F., Band 1.

Ford, E., 1928. "Herring Investigations at Plymouth. 1. Methods of Collection and Treatment of Data." Journal of the Marine Biological Association, Vol. XV. 1. p. 237.

Fulton, W. J., 1922. "Report on Herring Trawling Investigations." Fishery Board for Scotland. Scientific Investigations, 1921, II. (June, 1922).

Hjort, J. H., 1912., in "The Depths of the Ocean", p. 701. Murray and Hjort, London.

Wood, H., 1935. "Scottish Herring Investigations in the North-Western North Sea, 1934." Rapports et Procès-Verbaux. XCIV, 3ième partie.

A Preliminary Account of the Sprat and Sprat Fishery in England.

By

J. Armitage Robertson,
Fisheries Laboratory, Lowestoft.

Introduction.

IN England the sprat is at present of little commercial value even when compared with other relatively unimportant food fish such as dabs or megrims. During the past ten years an average annual catch of 74,307 cwt. has had an average annual value of only £ 19,661, and the mean price over this period has only been 5/4 per cwt. Except in 1930, sprats have been the cheapest fish of all those recorded in the Ministry's statistics during the past decade. But this does not imply that the British public will not eat sprats and does not value them highly, for during the same period an average annual import of 58,802 cwt. of canned brisling cost the country £ 354,394 a year. The Norwegians command at least nine-tenths of this trade; and it is only during the past two years that the quantity and value of imported brisling has fallen.

Everywhere in Europe where sprat fisheries exist they occur in coastal, estuarine, or even landlocked waters. On the English coast no less than four different types of gear are used. Drift-nets are fished on the Suffolk and Kentish coasts and on the south coast as far west as Poole, where a sprat trawl is employed. Further west, in Devonshire, sprats are caught in seines, while in the Thames Estuary, at Brightlingsea and Tollesbury, stow-nets[1]) are used. Stow-nets were once used in the Wash, but this fishery no longer exists. This gear is also used in the Firths of Forth and Tay, whereas in Inverness Firth drift-nets are employed.

Adult sprats are caught in England from October to February or March but Thames whitebait, containing a variable proportion of young sprats, are caught throughout the year save for a close season in August and September. Only in Norway, and to a less extent in the Gulf of Finland, is there an important summer sprat fishery.

[1]) Square bag-nets with upper and lower beams, fished on the anchor cable.

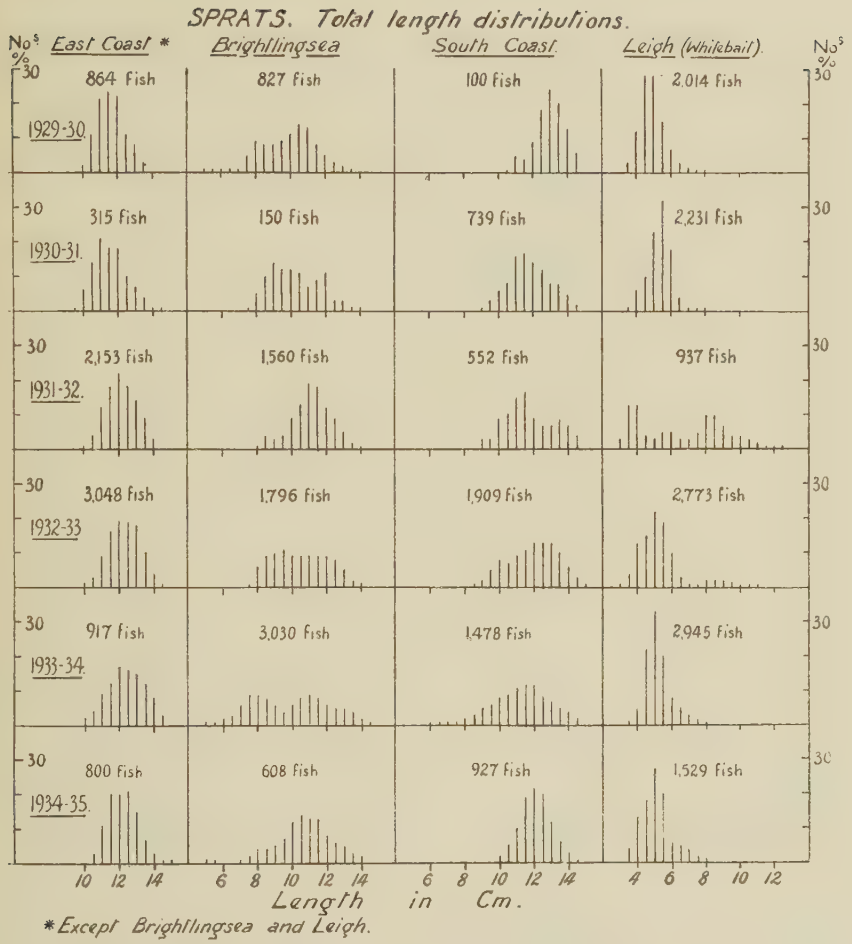


Figure 1. Length-frequency distribution of combined samples in each season and at different places.

Size and Age.

The sprats caught by commercial vessels in England have an extreme size-range of about 8 to 14 cm., but at most sprat fishing ports on the east coast the lower limit is somewhere between $9\frac{1}{2}$ and 10 cm., owing to the escape of smaller fish through the meshes of the drift-nets. This is the case from Lowestoft to Aldeburgh and again at Deal, but at Brightlingsea, which is the principal sprat port in the Kingdom, the stow-nets catch fish down to a length of about 8 cm. or even less. This difference in the selectivity of the gear used is plainly shown in Fig. 1 by the higher proportion of fish below 10 cm. taken at Brightlingsea. I have evidence from catches made with a stow-net by the

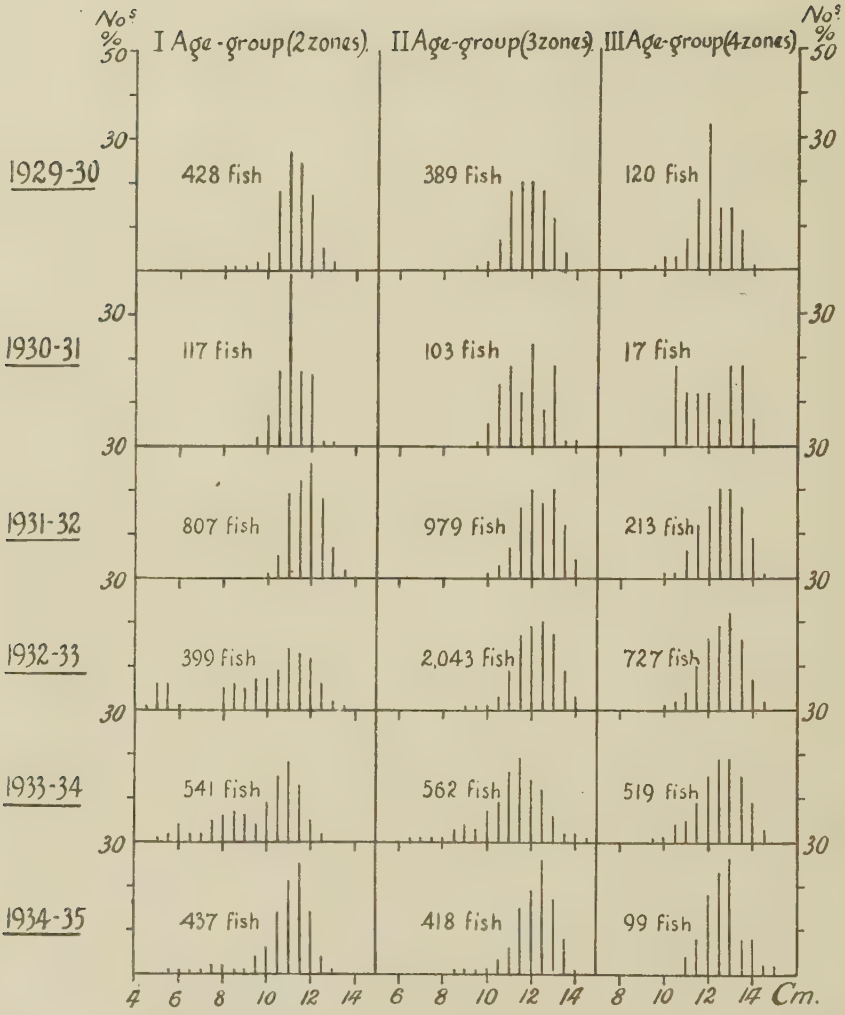


Figure 2. Length-frequency distribution of separate age-groups in each season. All scale-bearing east-coast samples combined.

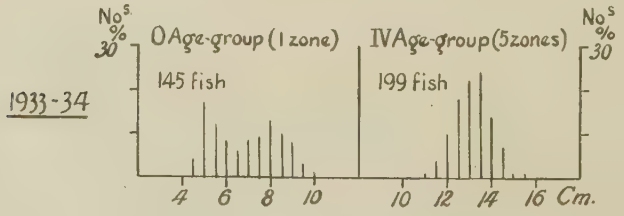


Figure 2a. Same data for 0 and IV-group in 1933/34. (In other seasons these groups are too small to be included).

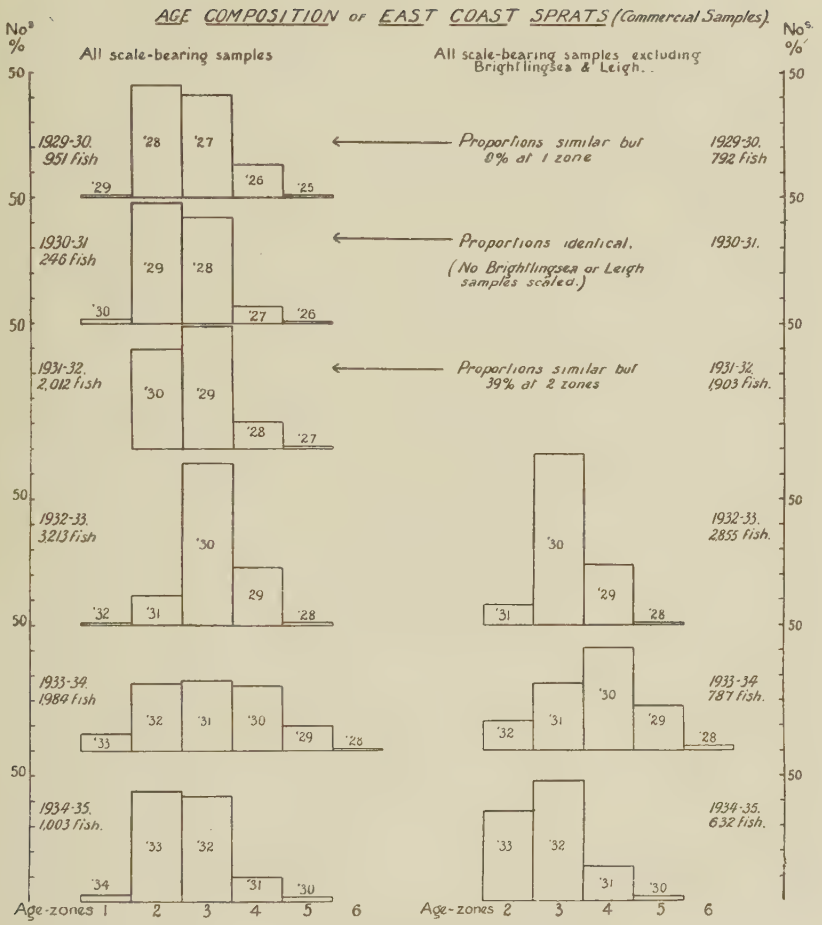


Figure 3. Age composition of east-coast sprats in each season. NB. For *drift-net samples alone* compare first three histograms on left with last three on right. (Brightlingsea stow-net samples are numerous in last three seasons only).

research ship "Onaway" that similar small fish are also present off the Suffolk and Kentish coasts, although they do not appear in the drift-net catches of commercial boats.

The majority of sprats taken by every kind of gear usually seem to be about 10 to 13 cm. in length, as may be seen from the position of the chief modes in Fig. 1. There is, however, a good deal of variation in the position and relative importance of the principal modes from season to season, from catch to catch and from one part of the coast to another. It should not be hastily assumed that this is entirely due to different age composition alone, for the separate age-groups are themselves usually multimodal and the principal mode in each group is not fixed (Fig. 2).

The age composition was determined by means of scales whenever they were available. An attempt to correlate scale and otolith readings, made by myself and three or four other members of this staff (following the otolith method used by Dr. Lissner of Hamburg) broke down completely owing to the wide discrepancies between our respective otolith readings and also between the readings of otoliths and scales from the same fish. The otoliths proved to be unquestionably ambiguous.

Fig. 3 shows the percentage age composition of east-coast sprat samples for the past six seasons. Only in the last three seasons has it been possible to obtain scales from Brightlingsea fish, which, being caught in stow-nets, have a lower size-limit. Drift-net catches usually provide scales in abundance.

If we refer to the data which exclude Brightlingsea and Leigh, we can compare the drift-net samples alone (right-hand histograms) with those caught by both types of gear together (left-hand histograms), and it is evident that 2-zone fish (I-group) are incompletely represented in the catches of the drift-nets, whose selective action thus excludes from the catch a proportion of the youngest recruits to the sprat shoals. In 1933—34 this also seems to have affected the 3-zone fish.

Although catch and population thus differ to some extent, two or three obvious facts are shown by this figure.

Firstly the life of the sprat is extremely short, five or six years at most, and secondly the bulk of the stock comprises only three year-classes (age-groups I, II and III, with 2, 3 and 4 growth-zones, and respectively $1^1/_2$, $2^1/_2$ and $3^1/_2$ years old). Obviously there is no large reserve of year-classes available to counteract the results of a year of poor brood-survival or other cause of fluctuation in the stock.

Taken individually, it seems that *year-class 1928*[1] was fairly strong both as 2-zone fish and 3-zone fish, but *year-class 1927* was probably rather below the average, as it does not predominate as 3 zone fish and is exceptionally weak as 4's.

Year-class 1929 is strong throughout its existence, as 2's, in spite of incomplete representation in the catch and even as 4-zone and 5-zone fish.

Year-class 1930 is not strong enough, when partially represented as 2-zone fish, to overtop the numerous year-class 1929, but as 3's it dominates the year-class 1929 (now much reduced by mortality as 4-zone fish) and also the very poorly represented year-class 1931 (as 2-zone fish), towering above both and remaining numerous as 4's in the following year.

Year-class 1931 is weak and poorly represented throughout its existence. This year's brood was obviously a failure, for which we have additional evidence from the scarcity of Thames whitebait (0-group) during the winter of 1931/32. During much of the winter and spring I was unable to obtain even the small samples required for my work.

---

[1]) Each year-class is identified by its year of birth.

Year-class 1932 made a poor entry as 2-zone fish, but as 3's it dominates the initially weak year-class 1931, now further reduced as 4's, and also *year-class* 1933, which makes its appearance as 2-zone fish in moderate numbers.

In short, the year-classes 1929 and 1930 were exceptionally strong and that of 1931 extremely weak. The seasons when 2-zone fish were dominant (1929/30 and 1930/31) were those in which there were most fish below 11 cm. on the east coast (excluding Brightlingsea and Leigh: Fig. 1). In 1933/34, when 4 and 5-zone fish were unusually common, there were more fish between 13 and 14.5 cm. than in other seasons, though this is less obvious than is the former case, probably because of the slower growth of the sprat in its later years.

Within each separate age-group (Fig. 2) the more important modes present are probably the result of batches in a spawning extending over a very long period. This seems, at present, to be the most feasible explanation, even though the multimodal character of the curves persists among the older age-groups. A wealth of scattered observations on planktonic sprat eggs and larvae shows that the spawning must continue from, at least, March to July in the North Sea and Channel, and H e i d r i c h has shown that the spawning of the Baltic sprat is both rhythmical and prolonged.

It can be seen that the range of size is nearly the same in I, II and III-group fish and that the modes are remarkably similar. This can only mean that growth after the second winter (I-group) is very limited.

All length observations of fish belonging to the same age-group and caught during the six seasons 1929/30 to 1934/35 were combined, and a percentage length-frequency distribution was drawn for each group separately. By plotting the positions of the *main* modes of these age-groups, a curve of growth such as that in Fig. 4 is obtained. Owing to the scarcity of the 0-group in the adult shoals, the point for the 0-group (1-zone) fish was likewise obtained from the main mode of the combined whitebait samples. The whitebait sprats, judging from their size and such scale evidence as is available, are largely pure 0-group fish in the winter. Growth curves drawn by other methods are very similar, but Fig. 4 is perhaps the simplest expression of the data.

It can be seen at a glance that growth is rapid up to $1^1/_2$ years of age (I-group, 2-zone fish)[1]) and thereafter diminishes abruptly. The initial period of rapid growth covers the first two summers of life, and at $1^1/_2$ years of age the sprats make their first appearance in the adult sprat catches in winter.

[1]) In Fig. 4 the size of I-group fish is probably somewhat enhanced by net selection.

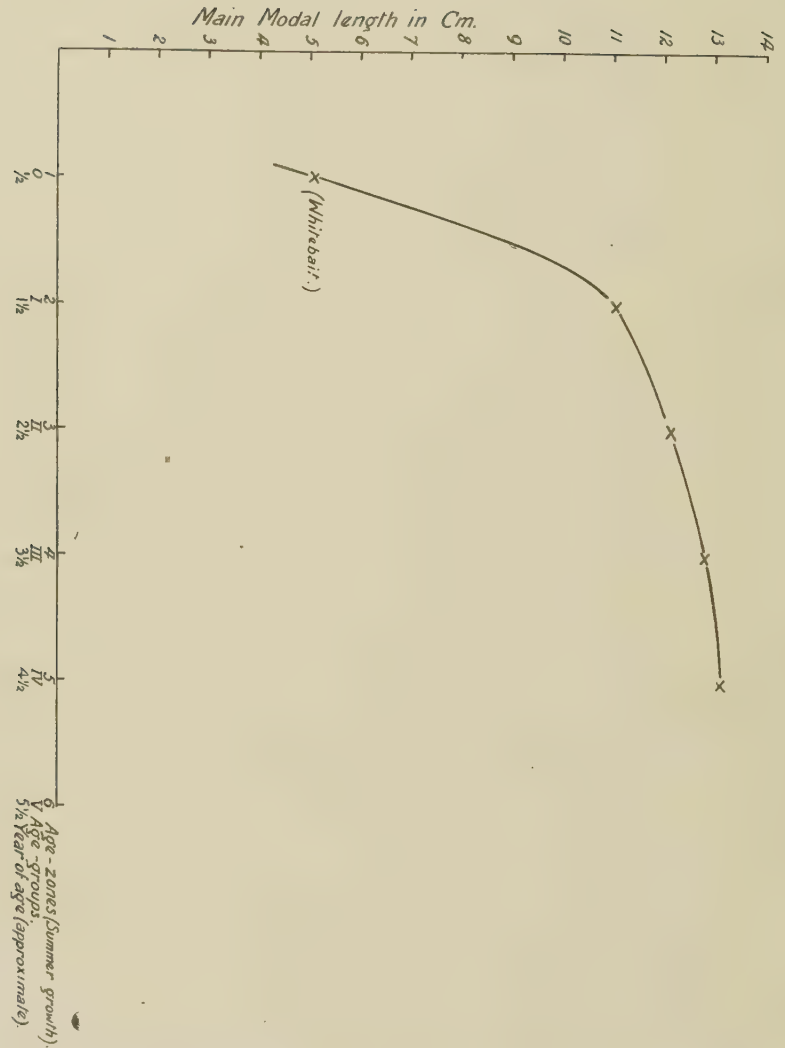


Figure 4. Growth-rate in all scale-bearing east-coast sprats: derived from principal modes of combined length observations (from 1929/30 to 1934/35) of each age-group.

Condition (Maturity, Fat, and Stomach Contents).

This sudden diminution in growth coincides with the first approach of sexual maturity, and maturation is evident in fish of all sizes found in the winter catches. In the early weeks of the season (November) the ovaries rarely contain visible, opaque eggs, but these appear towards the middle of the season (December—January). Between Christmas and the end of the fishing season in February or March a

gradual increase in size of ovaries and testes and in discernibility of the eggs is apparent.

Although for the sake of conformity I have adhered in my observations to the Hjort maturity stages, I do not think that in the sprat they define the imperceptible stages of the gradual process of maturation any more exactly than ordinary observation expressed in plain English, and I am also of opinion that in the sprat the presence of mesenteric fat is not a safe criterion of a virgin fish.

The commercial catches rarely, if ever, contain "maizy" (running) sprats, but I found small sprats of only 7 to 9 cm. in length with transparent and almost running eggs in the spring of 1932. They came from what passed as whitebait in the 1931/32 season of great scarcity, but in size they resembled the smaller fish of the Brightlingsea winter shoals, and were probably ill-grown I-group fish.

It seems that in English waters the sprat spawns for the first time in spring or summer at an age of about 2 years ($1^1/_2$ years in the preceding winter), for it is very unlikely that they can normally mature as $^1/_2$ to 1-year-old whitebait at a length of 5 or 6 cm. The larger whitebait sprats which I have occasionally examined usually have thread-like or indiscernible gonads.

The strain thrown upon the organism in maturing its gonads is no doubt responsible for the sudden diminution in growth after the first 18 months of life. There is no doubt that the maturing fish draw heavily upon their reserves of fat during the winter, and Fig. 5 shows the seasonal fluctuation in the fat content, which I have found during the past three seasons. The figures for the first season were obtained by a method, recommended by the Government Chemist, involving only 5 gm. of flesh, but for the last two seasons I modified the method so as to analyse samples of half a kilogramme. The fish were beheaded and tailed, and the figures really represent the quantity of "ether-soluble substance" obtained from a hydrochloric acid digest of the minced tissues. The curves for each year agree well enough with each other and with similar Norwegian curves for 1908/09 and 1909/10 (S u n d). The old contention that English sprats are poor in fat is not substantiated by my results, at least as regards the fat content during the first half of the fishing season (in autumn) when figures of 12 % to 15 %, resembling those of Norwegian sprats, are regularly found.

Some fat determinations made by the Government Chemist in 1915 and 1916, and by Professor J a m e s J o h n s t o n e in 1918 and 1919 agree in the main with my results. The former found a surprisingly low fat content in summer (2.48 % and 3.32 % in June and August 1915) for which I have no data.

Although the maturing sprats in the winter shoals draw upon their reserves of fat, they do not seem to feed. In 1932/33 and 1933/34 respectively, some 5,000 and 700 sprat stomachs were examined by Mr. H. H. G o o d c h i l d of this laboratory, who could find no recognizable traces of food organisms. (In one fish he found remains of a few *Temora* and in another a piece of coal!)

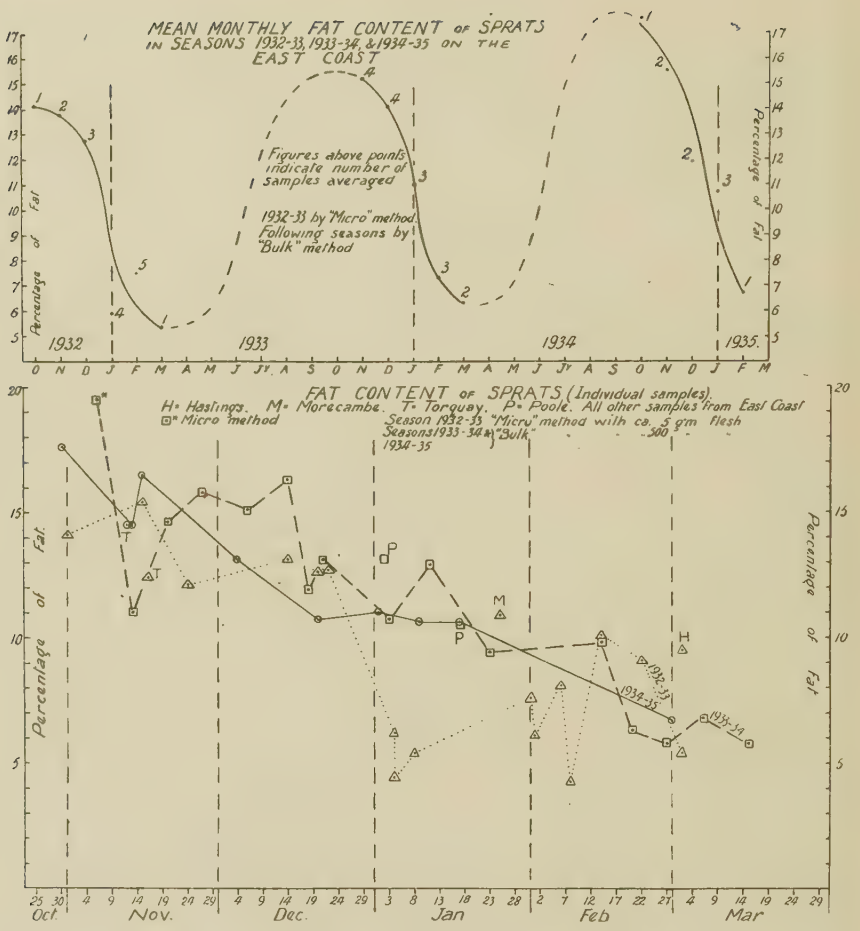


Figure 5. Fat content of sprats in three successive seasons.
Above: Mean monthly values.
Below: Fat content of each sample.

I examined eleven samples (containing 22 to 33 stomachs each; 306 stomachs in all) collected during 1934/35, and in two samples only was there any appreciable quantity of recognizable food. A majority of fish in these two samples had been feeding very sparingly on crustaceans, chiefly copepods, and in one of the samples occasional lamellibranchs, foraminifera, and diatoms were also present. In the other nine samples food (of similar character) was extremely scarce or non-existent.

The fish virtually fast from late October or early November, until February or March. This is very different from the state of affairs in the Norwegian summer fishery for brisling, where the fish are impounded in the seines for some time, so that they may empty their intestines before being brought ashore.

Migrations; Thames Whitebait; Vertical Distribution.

It would be of particular advantage to the canning trade if sprats could be caught throughout the year, but there are few indications of their presence off the coast in summer. They are occasionally taken in trawls, a few at a time, well out to sea and they have been recorded in herring drift-nets off the Tees, in sprat drift-nets off Yarmouth, in seines in the River Plym, and in trawls and seines in the Clyde. But in view of the number of shrimp trawls fished in shallow waters off the coast in summer it is unlikely that any appreciable inshore concentration would go undetected in such places. It seems likely that, once the shoals leave the coast in spring, the fish scatter seaward to spawn or disperse after spawning to feed and do not reassemble until the following autumn.

The whitebait sprats do not, however, take part in this mass-migration seaward, at least until late summer, for they are found continuously in the Thames from October till the close season in August, and their length-frequency curves form a continuous series showing surprisingly little growth[1]). The curves, which are too numerous for publication here, show a contraction of the size-range and assume a markedly unimodal form from about April or May onward. This may be due to an increase in size of the smaller fish and to a gradual filtration seaward of the larger individuals. The contraction of size-range (more marked in some seasons than others) is perhaps an indication of the onset of a summer period of active growth.

In two seasons there were definite indications of the entry of the new year-class in July, but it is probable that this usually occurs during the close season in August and September, for the modal lengths in October are lower than in July and indicate that the 0-group have displaced the previous year's whitebait, which were still present in the Thames as I-group fish in July. One sample of whitebait sprats — the final sample of a long series — taken in July 1931 fortunately bore scales and provided clear evidence that some whitebait sprats remain in the Thames well into their second summer (I-group fish with 2 growth-zones).

This particular sample was, however, probably composed of late-spawned or ill-grown fish, for with a mode at 5.6 cm. it is unlikely that they could have grown to the usual size at which I-group fish first appear in the adult shoals only three months later.

The proportion of sprats and herrings present in the Thames whitebait has been regularly observed for the past six seasons, involving the examination of 92 samples usually containing 150 fish each. The proportion of sprats varies irregularly from October until June or July between 70 % and 100 %. From the latter months until the close season in August a very sudden fall occurred in 1933, '34, and '35 to

[1]) This is no doubt partly due to the frequent occurrence of degeneration of the caudal fin-rays in the summer months. This defect, which may also extend to the pelvic fins, is sometimes apparent in almost every fish.

values varying between 3 % and 50 % of sprats, but in 1931 this drop did not occur and in 1930 no samples were obtained after May. In 1932 also the percentage of sprats was very low in June and July, but whitebait had been very scarce during the season and the data are rather unsatisfactory.

Occasional samples containing a low proportion of sprats occur between October and July, and conversely samples with a relatively high proportion between June—July and August, but they are exceptional.

It seems that sprats predominate during most of the year, but that herrings are in the majority during the summer until the close season. This is in agreement with Ewart and Matthews's results for the months from February to August in 1885—'86, but differs from Wallace's numerous (but not consecutive) observations during 1913 to 1916 as reported by Hodgson. Wallace found a much higher proportion of herrings from October to January than was shown by my samples.

Hodgson attributes the rise in percentage of herrings (or fall in percentage of sprats) during June to the entry of 0-group herring. But as his figures show that this new entry first occurs in March and April, I think that a gradual departure of I-group sprats is at least a contributory cause.

The vertical distribution of the fish in adult shoals evidently varies, for they are caught near the surface in drift-nets and on the bottom in sprat trawls (at Poole). The stow-net, which is highly successful where tides are strong, fishes almost from surface to bottom. I have succeeded in fishing with sprat drift-nets and a sprat trawl simultaneously on the same ground, and on two or three occasions found sprats in the foot and middle of the drift-nets but none at the surface in the head of the drift-nets, or on the bottom in the trawl. As we were fishing close inshore in shoal water, this shows that the sprats were approximately in mid-water and nowhere else, and it is perhaps the first time that such an experiment has been performed by a single vessel fishing for a single species.

Factors affecting the Fishery and its Development.

Several factors combine to render the sprat fishery specially liable to fluctuation. The sprat is short lived; the stock is dependent on only a few year-classes and is, moreover, migratory. The fishery is strictly seasonal, occurring during the inshore migration in winter when interruption by bad weather is most frequent, and it is prosecuted by very small boats which are easily inconvenienced by unfavourable conditions. On the east and south-east coasts at least, the shoals apparently vanish during severe north or east winds, but south or west winds do not seem to have the same effect.

The great Norwegian sprat fishery and the much smaller fishery in the Elbe have experienced very violent fluctuations in the past, and

if the English fishery was at all intensive the natural tendency to fluctuate might be aggravated. But of this there is little danger at present, for the sprat is fished in a sporadic manner, at scattered places, along certain stretches of the coast only, and by the smallest type of boat. The sprat fishery in England is of most importance on the east coast, particularly at Brightlingsea, but it extends no further north than Lowestoft. Poole is the chief port on the south coast, where sprat fishing is otherwise very desultory, and there is no fishery at all on the west coast.

Slight though the fishery is, the demand is sometimes non-existent, and sprats have often been sold for manure or thrown overboard. The mainstay of the fishery is a trade in pickled and spiced fish, mainly exported from Brightlingsea to Sweden and Germany for treatment as delicatessen. Even this outlet is subject to severe competition from the fishery at Ostend.

If there was any increase in demand — by the canning industry, for instance — it is probable that the supply could be largely increased, by expansion in the area fished and in the number of boats employed, without adversely affecting the stock available.

References.

Ewart, J. C. and Matthews, J. D. On the nature of Thames and Forth Whitebait. 4th Ann. Rep. Fishery Board for Scotland, for 1885, Appendix F. No. V, 1886.

Heidrich, H. Über die Fortpflanzung von *Clupea sprattus* in der Kieler Bucht. Wiss. Meeresunters. (Abt. Kiel), N. F. Bd. 20, Heft 1, 1925.

Hodgson, W. C. Investigations into the Age, Length and Maturity of the Herring of the Southern North Sea. Part III. Min. Agric. and Fish., Fish. Invest., Ser. II, Vol. XI, No. 7, 1929.

Johnstone, J. The methods of Fish Canning in England. Min. Agric. and Fish., Fish. Invest., Ser. I, Fresh-water Fisheries and Miscellaneous. Vol. II, No. 1. 1921.

Sund, O. Undersøkelser over brislingen i Norske farvand. (Reprint from Årsber. vedk. Norges Fiskerier). Bergen, 1911.

Die Turbinen und die abwärts wandernden jungen Lachse und Forellen (sowie Aale).

3. Teil.

Von

C. V. Otterstrøm,

Dän. Biol. Station, Abt. für Binnenfischerei,
Frederiksdal bei Lyngby, Dänemark.

IN Fortsetzung der früher gemachten Versuche mit kleineren Turbinen-Anlagen (von 1.2—2.8 m. Fallhöhe und 1.5—25 PS) (Journ. du Conseil, VI, 1931 und VII, 1932) hat die Biologische Station einige Versuche angestellt, Forellen (und Aale) durch drei grössere Kraftanlagen an der Gudenaa — bei Tange, Vestbirk und Silkeborg — durchschlüpfen zu lassen. Die Ergebnisse sind nachstehend mitgeteilt.

1. Kraftstation von Tange. (Versuch vom 21.—22. IX. 1932).

Die Kraftstation der Gudenaazentrale bei Tange (Fig. 1) hat drei Turbinengruppen. Jede Gruppe ist als Zwillingsturbine konstruiert, nämlich als zwei Doppelturbinen auf gleicher Welle (Fig. 2). Die Turbinen sind schwedisches Fabrikat, von der Firma "Verkstaden", Kristinehamn. Bei der einen Gruppe kann die eine Doppelturbine allein laufen, wenn nicht volle Kraft gewünscht wird. Die Fallhöhe wechselt zwischen ca. 7½ bis 10 Meter, je nachdem eine, zwei oder drei Turbinen in Betrieb sind. Bei einer Nettofallhöhe von 7 Metern entwickeln sich auf der Welle in einer Turbine 1500 PS, bei 8 Metern (der gewöhnlichen Höhe) 1800 PS und bei 9 Metern 2150 PS. Die Turbinen sind Francisturbinen; der grösste Durchmesser des Laufrades ist ca. 1 Meter, die Zahl seiner Schaufelblätter beträgt 16; es macht 214 Umdrehungen in der Minute.

Der Ausströmungsraum hat bedeutende Ausmasse. Er ist 20.65 m. lang und 5.30 m. breit; seine Tiefe geht unter den Saugröhren bis auf Kote − 0.7 hinunter, während sonst der Boden des Ablaufes in Kote + 2.7 liegt — es befindet sich dort also eine Grube von 3.4 m. Tiefe. Die Saugröhren gehen so tief hinunter, dass sie selbst bei Niedrigwasser (Kote 3.2) unter den Wasserspiegel hinunter reichen; bei hohem Wasserstand reichen sie also tief in das Wasser hinunter, und um die Saugröhren herum muss sich sicher totes Wasser bilden, in dem der Fisch

sich leicht halten kann, was gewisse Schwierigkeiten bei der planmässigen Durchführung der Versuche erklärt. Hätte man allein durch das vordere Saugrohr Wasser schicken können, wäre das Ausspülen der Fische vielleicht besser geglückt; aber leider konnte nur das hintere Saugrohr alleine wirken.

Fig. 1. Kraftstation bei Tange. Quer über dem Staukanal hängt ein Netz, das in das Wasser gesenkt werden kann; es sollte verhindern, dass die Fische bis zu den Turbinen vordrangen und sie zur Fischtreppe leiten, die zwischen den beiden Masten rechts beginnt; das Netz konnte aber nicht an dem Boden gehalten werden, wenn die Maschen von Planktonalgen verstopft wurden, was schnell geschah. Vor dem Maschinenhaus (das Gebäude rechts) sieht man die Eingänge zu den drei Turbinenkammern. (C. V. O. phot. 19/IX. 1924).

Unter normalen Verhältnissen brauchte die Kraftstation die ganze vom Hinterland kommende Wassermenge, abgesehen von dem Wasser, das durch die Fischtreppe geht (22 l./sek.), durch die Dämme und die Freischleuse absickert (60 l./sek.), durch verschiedene Abzugsröhren läuft (10 l./sek.) und schliesslich durch die stillstehenden Turbinen verloren geht (für alle drei Turbinen zusammen 470 l./sek.). Eine Turbine im Betrieb braucht 15,410—16,590 l./sek. Wasser; zwei Turbinen, die gleichzeitig in Betrieb sind, brauchen mehr als das Doppelte (36,275 l./sek.). Diese Zahlen sind dem Bericht "Beretning om det danske Hedeselskabs kulturtekniske Afdelings hydrometriske Undersøgelser 1923—1924" (Slagelse, 1925) entnommen. Die Ergiebigkeit der Gudenaa betrug in der dort behandelten Untersuchungsperiode — November—Dezember 1922 — ca. 17,000 l./sek.

Um den Versuch vorzubereiten war in den vorhergehenden Tagen ein Holzrahmen von 450 × 525 cm. angefertigt worden, der in ein Falz hineinpasste, der in der Mauer an den Seiten der Ausströmungspforte ausgespart war. Auf diesem Rahmen war ein Fangbeutel von gelohtem Twist (Maschenweite 9 mm., Garn 30/15) angebracht. Der Beutel war 18 Meter lang, der Umfang an der Mündung ca. 20 Meter;

Fig. 2. Blick in die geleerte Turbinenkammer. Von der einen Zwillingsturbine sieht man die Leitschaufeln an beiden Enden; von der anderen den einen Satz der (geschlossenen) Leitschaufeln. Zwei Mann sind damit beschäftigt, den Trichter zum Hinunterschütten der Fische zwischen zwei Leitschaufeln anzubringen; hier sind die Schaufeln geöffnet. Ungefähr parallel mit dem Trichter steht eine Leiter. (C. V. O. phot. 21/IX. 1932).

er war mit einer einzigen Kehle versehen; hinten wurde er mit einer Schnur zusammengebunden. Das Endteil des Beutels bestand aus dem bei früheren Versuchen mit kleineren Turbinen verwendeten Fangbeutel (etwas kleinere Maschen und schwererer Twist, sogen. Krabbengarn). (Vergl. Fig. 9.).

Vorläufig hing der Rahmen mit dem daran befestigten Fangbeutel über dem Wasser, zum Versenken bereit.

Um die Versuchsfische auch wirklich in die Turbine hinein zu bringen, wurde ein 5 Meter langer, viereckiger Trichter aus zusammengezimmerten Brettern hergestellt (innere Lichte ca. 31 × 46 cm.). Sein

unterer Teil wurde zwischen zwei Leitschaufeln geführt und mit Eisenbeschlag festgemacht (Fig. 2—3), während sein oberer Teil aus der Turbinenkammer hervorragte. Die Bretter waren unbehobelt, — es können dadurch vielleicht einige der in den Trichter hineingelassenen Fische einige Schrammen bekommen haben.

Fig. 3. Unten in der geleerten Turbinenkammer. Der Trichter ist zwischen zwei Leitschaufeln in Stellung gebracht und wird nun mit Eisenbeschlägen befestigt. Die Schatten auf der Wand stammen von Leuten oben auf dem Deckel am anderen Ende der Leiter (C. V. O. phot. 21/IX. 1932).

Nachdem dieser Trichter auf seinem Platz angebracht war, wurde der Rahmen mit dem Fangbeutel hinunter gelassen. Der Grund unter dem Rahmen war nicht ganz eben, weswegen der Rahmen auf der Unterseite mit Heidekraut beschlagen war. Da die Ausströmungspforte gut 5 Meter breit war und ihre Wassertiefe ca. 4 Meter betrug, ist es nicht sehr wahrscheinlich, dass Fische (vielleicht mit Ausnahme von Aalen) es versuchen sollten, sich durch die Heidebüschel unter dem Rahmen hindurch zu bohren. Das Boot, von dem aus der Fangbeutel bedient werden sollte, wurde hauptsächlich dadurch manövriert, dass es an einer ausgespannten Leine hin und her gezogen wurde. (Fig. 4). Die Versuchsfische (2 Grössen Regenbogensatzforellen sowie Regenbogenmutterforellen) waren in der Teichwirtschaft der Kraftstation

aussortiert und wurden in Bereitschaft gehalten; 20 Aale lieferte der Fischer vom Tange See, und diese wurden ebenfalls bereit gehalten. Um 15.15 Uhr war alles klar, sodass die Versuche beginnen konnten.

(1) Die Turbine wurde um 15.15 Uhr in Gang gesetzt und 5 Minuten später wieder gestoppt. Es galt nämlich nur, teils zu prüfen, ob der Fangbeutel sich glatt entfalten würde, teils den Ausströmungsraum von Fischen zu reinigen. Der Beutel funktionierte sehr gut, es wurden

Fig. 4. Der Fangbeutel wird eingeholt. Der oberste Teil vom Rahmen des Beutels ist eben über der Wasserfläche in der rechten Turbinenpforte sichtbar. Das Boot ist an dem im Bogen hängenden Tau festgemacht. (C. V. O. phot. 21/IX. 1932).

auch eine Anzahl Fische gefangen (Barsch, Güster, Uckeleien usw.), aber, wie es sich später zeigte, war dieses Ausspülen sehr unvollständig gewesen.

(2) Die Turbine wurde wieder in Gang gesetzt. Um 15.40 Uhr wurden 51 Regenbogenforellen von ca. 15—22 cm. Länge in den Trichter geschüttet; die Saugkraft in diesem war so gross, dass das Wasser im Trichter etwas niedriger stand als aussenvor. Um 15.45 Uhr wurde gestoppt und der Fang untersucht. Er ergab nur einen Aal — keine Regenbogenforellen. Bisher war nur mit der einen Doppelturbine gearbeitet, jetzt wurde auch die andere eingesetzt (15.50—15.55 Uhr), um die Fische aus allen Ecken im Ausströmungsraum herauszubringen. Es wurden aber nur 2 lebende und 1 partierte Regenbogenforelle gefangen sowie einige Kleinfische. — Wir mussten es also aufgeben, vor dem Beginn der nächsten Versuchsabteilung alle Regenbogenforellen herauszufangen.

(3) Die Turbine wird wieder in Gang gesetzt und 54 Regenbogenforellen von ca. 10—15 cm. Länge in den Trichter geschüttet. Beide Doppelturbinen laufen vollbelastet während 10 Minuten (16.10—16.20). Es wird gestoppt und der Fang untersucht: 3 Regenbogenforellen und einige Kleinfische und Aale.

Fig. 5. Vom Boden der geleerten Turbinenkammer zum Gitter hin. Dieses ist aus mehreren Teilen zusammengesetzt; besonders wo diese aufeinander stossen, ist der Abstand zwischen den einzelnen Stangen oft grösser als der normierte Abstand von 20 mm. (C. V. O. phot. 21/IX. 1932).

(4) Beide Turbinen laufen vollbelastet während 20 Minuten (16.28—16.48). 4 Regenbogenmutterforellen von je ca. 1 kg. und 20 Aale von verschiedener Grösse werden in den Trichter geschüttet; nach Verlauf der 20 Minuten wird gestoppt und der Fang untersucht. Weder Aal noch Mutterfisch sind gefangen, dagegen 5 Regenbogensatzfische sowie viele Kleinfische (Uckeleien, kleine Barsche, kleine Güster — oder Brachsen — u. a.).

Von den bisher gefangenen 11 Regenbogensatzfischen waren 10 lebensfähig.

(5) Ohne Nachschub von Fischen wurden die Turbinen 20 Minuten vollbelastet in Gang gehalten, danach gestoppt und der Fang untersucht. Er bestand aus 2 Mutterfischen (der eine partiert, der

andere erschlagen), 18 Aalen (2 erschlagen), 3 Zandern (von 37—39 cm. Länge), einigen Kleinfischen sowie 23 lebenden, 4 ganzen, aber toten und 2 partierten Regenbogensatzfischen.

(6) Die Turbinen laufen vollbelastet eine halbe Stunde. Nach dem Stoppen ergibt Untersuchung des Fanges 1 lebende Regenbogenmutterforelle (ca. 35 cm.), 6 lebende Satzfische, 6 Aal, Barsche, 1 recht grosse Plötze, Uckeleien und andere Kleinfische.

Fig. 6. Die Kraftstation von Vestbirk vom Hinterwasser aus gesehen. Zwei Turbinenpforten. Das brausende Wasser in der Mitte des Bildes kommt aus einem Aalpass. (C. V. O. phot. 22/IX. 1933).

(7) Um die Fische vollständig zu ermüden und damit in den Fangbeutel zu treiben, werden die Turbinen 1½—2 Stunden lang vollbelastet in Gang gehalten; um 20.30 Uhr wird gestoppt und der Fang untersucht. Er bestand aus 13 Regenbogensatzforellen, die alle lebten, zahlreichen Kleinfischen (Barschen, Uckeleien, 2 kleinen Zandern — 15—16 cm. — 1 Stint), 1 Zander von 38 cm. und nicht weniger als 74 Aale, von denen einer erschlagen war und ein anderer den Schwanz etwas beschädigt hatte. — Einige Fische, z. B. der Zander von 38 cm., haben vermutlich während aller Spülungen im Ausströmungsraum gestanden; dagegen sieht es so aus, als ob viele Kleinfische und Aale abends durch das Gitter (Fig. 5) in die Turbinenkammer hineingegangen sind, die ja am Vormittag leer war; die Aale können aber auch im Ausströmungsraum gelegen haben, um erst hervorzukommen, als es dunkel wurde. — Bei der letzten Fanguntersuchung wurde schon künstliches Licht benutzt, und die Arbeit musste daher für den Tag eingestellt werden. Die bei dem Versuch benutzten Turbinen standen

still bis zum nächsten Vormittag um 10.45 Uhr. Der Fangbeutel blieb auf seinem Platz.

(8) Am 22. September vormittags wurde zunächst der Fangbeutel untersucht, durch den seit dem vorhergehenden Abend kein Strom gegangen war. 1 Regenbogenforelle, 1 Zander (ca. 35—40 cm.), 1 Aal, 2 Quappen (ca. 15 und 20 cm.), Kleinfische.

(9) Beide Turbinen werden in Gang gesetzt und laufen mit voller Belastung von 10.45 bis 11.00 Uhr. Es wird gestoppt und der Fang untersucht. Keine Regenbogenforellen, 2 Zander (beide ca. 15 cm.), Kleinfische.

(10) Die Turbinen laufen mit voller Belastung von 12.00 bis 13.15 Uhr. Es wird gestoppt und der Fang untersucht. 11 Regenbogensatzforellen, 5 Aale, Kleinfische.

Der Fangbeutel wird aufgenommen und die Versuchsreihe unterbrochen.

Übersicht über das Ergebnis.

Regenbogenforellen	ausgesetzt	nicht wiedergefangen	wiedergefangen		
			unbeschädigt	tot	
				ohne Schlagmerkmal	mit Schlagmerkmal
10—15 cm. ...	51	19	29	2	1
15—22 cm. ...	54	17	31	4	2
Mutterfische ..	4	1	1	0	2

Rechnet man die nicht wiedergefangenen sowie die toten, aber nicht sichtbar verwundeten Fische, unter die von der Turbine unbeschädigten, wird der Schadenprozent:

10—15 cm.	51 — 1	2 %
15—22 cm.	54 — 2	4 %
10—22 cm.	105 — 3	2.9 %
Mutterfische	4 — 2	50 %

Würde man dagegen alle nicht wiedergefangenen Fische unter die toten rechnen — was, wie unten gezeigt, unbillig scheint — wird der Schadenprozent:

10—15 cm. ...	51 — 20	39.2 %
15—22 cm. ...	54 — 19	35.2 %
10—22 cm. ...	105 — 39	37.1 %
Mutterfische ...	4 — 3	75 %

Es ist nicht zu verwundern, dass einige Forellen während der Untersuchung des Fangbeutels starben, denn dieser war so gross, dass die Untersuchung nicht immer schnell genug erfolgen konnte. Wenn aber die Forellen eine Zeit lang vorher kein Futter bekommen hätten, hätten sie die Strapazen wohl schon eher vertragen können. Meiner Meinung nach sind wir vollauf berechtigt anzunehmen, dass die toten Forellen, die keine Schlagmerkmale zeigten und erst während oder nach der Untersuchung des Beutels starben, nicht infolge der Wanderung durch die Turbine starben, sondern infolge des, für einen vollgefütterten Fisch recht anstrengenden Aufenhaltes während der Versuche in dem starken Turbinenstrom und infolge der nachfolgenden Untersuchung. Was die nicht wiedergefangenen Regenbogenforellen betrifft, so muss man annehmen, dass sie unbeschädigt sind; sonst wären die Fische sicher mit dem Strom in den Fangbeutel getrieben. Für diese Auffassung spricht

auch noch folgendes: Die fünf Regenbogenforellen mit Schlagmerkmalen waren bis auf den einen Mutterfisch alle in zwei Teile geteilt worden, aber alle acht Stücke wurden gefunden; das Vorhandensein einer Anzahl unpaariger Stücke hätte bedeutet, dass innen in dem Ausströmungsraum noch andere Stücke hätten liegen müssen. Was die Aale betrifft, so können tote Individuen im Ausströmungsraume liegen bleiben; das zeigte der Fang eines verfaulten Aales. Die Erfahrung hat sogar gezeigt, dass Schlamm sich dort drinnen ablagern kann.

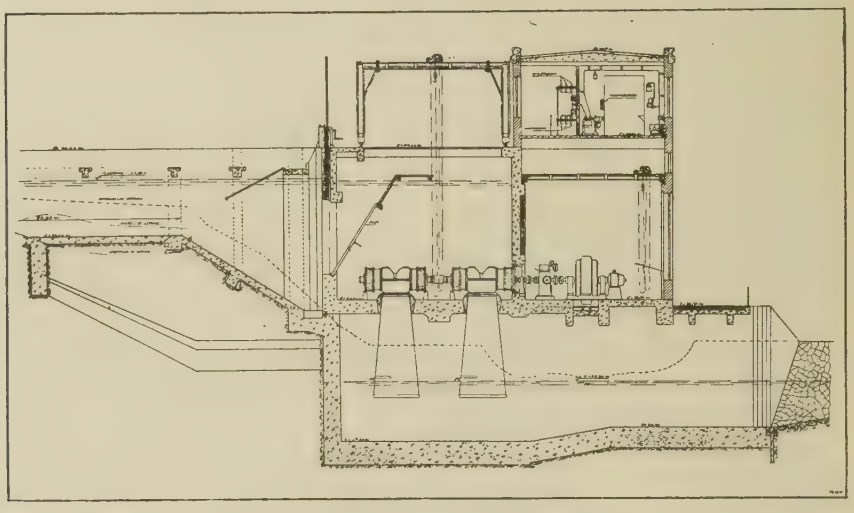


Fig. 7. Schnitt durch die Kraftstation bei Vestbirk. Gitter, Deckel, Doppel-Zwillingsturbine mit zwei Saugröhren. Der Fangbeutel konnte erst ganz rechts angebracht werden. Nach einem Bericht (Horsens 1926) der Kraftstation.

Mit Bezug auf die Aale ist jede Statistik über Sterblichkeit als Folge der Passage durch die Turbine unmöglich, da die Herkunft der gefangenen Aale nicht nachweisbar ist. Es wurden zwanzig Versuchsaale benutzt, aber über hundert gefangen, und nur von denjenigen mit Schlagmerkmalen kann man bestimmt sagen, dass sie die Turbine passiert haben, und das brauchen nicht die Versuchsaale gewesen zu sein. Es waren nur ungefähr zwanzig Gelbaale vorhanden, die übrigen waren Blankaale, meist Männchen. — Bei künftigen Versuchen mit Aalen sind die Versuchsindividuen im voraus zu markieren, sodass sie von anderen, die nicht in den Versuch eingehen, unterschieden werden können.

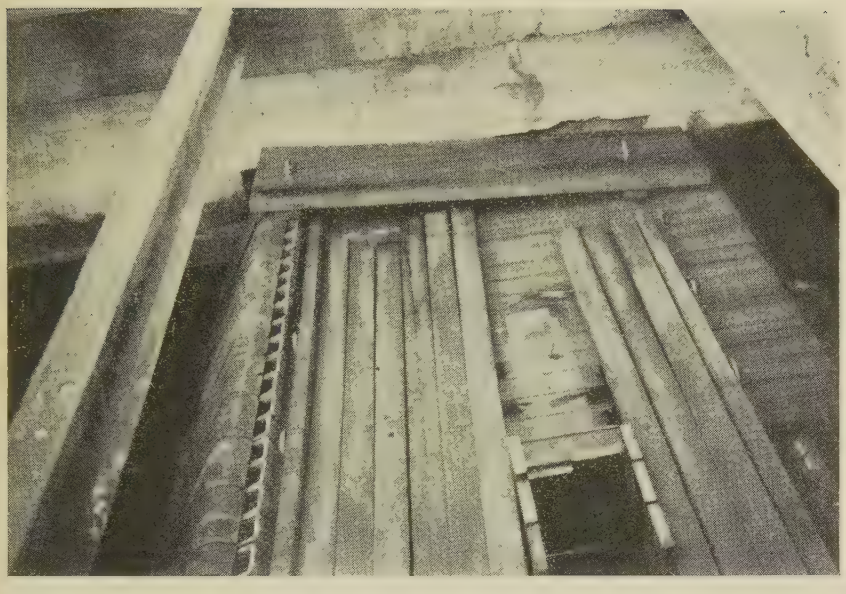


Fig. 8. Der Deckel der Turbinenkammer ist teilweise entfernt; durch das Loch ist der Trichter zum Hinunterschütten der Fische hinuntergeführt (man sieht das obere Ende); im übrigen ist das Loch mit Latten zugedeckt. Links sieht man das obere Ende des Turbinengitters. (C. V. O. phot. 22/IX. 1933).

Schlagmerkmale.

Regenbogenforellen,	54	cm.	Schlag	bei	19	(d. h. der Schlag hat den Fisch 19 cm. hinter der Schnauzenspitze getroffen)
„	52	„	„	„	25	zerstückelt
„	21	„	„	„	4	Kopf abgeschlagen
„	21	„	„	„	10	zerstückelt
„	15	„	„	„	6	zerstückelt
Aal	79	„	„	„	7, 18 und 67—75	
„	66	„	„	„	18 und 61—66	
„	63	„	„	„	12, 34	
„	51	„	„	„	20 und 45—51	
„	45	„	„	„	16	
„	35	„	„	„	31	Kleines Merkmal
„	39	„	„	„	3	(Kopf)

Die Aale sind mit 1—3 Schlägen getroffen worden. Der Abstand zwischen den Schlagmerkmalen ist nicht regelmässig, sondern variiert zwischen 11 und 49 cm. Bei drei Aalen fanden sich schwere Hautabschürfungen auf dem Schwanz — vermutlich dadurch entstanden, dass der Aal sich krampfhaft zusammenzieht, wenn er weiter vorne auf dem Körper getroffen wird.

Dass eine Anzahl Aale bei der Passage durch die Turbinen getötet werden, ist zu erwarten; aber auf Grund der vorliegenden Kenntnisse kann nicht gesagt werden, wie gross der Prozentsatz ist, der unbeschädigt hindurch kommt, und wie das Verhältnis innerhalb der verschiedenen Längengruppen ist.

Fig. 9. Der Fangbeutel ist nach dem Gebrauch bei der Kraftstation von Vestbirk zum Trocknen aufgehängt. Er sitzt noch auf dem Rahmen, der auf einer Handkarre liegt. Der Beutel hat bei der Öffnung einen Umfang von ca. 20 Meter und ist 18 Meter lang. (C. V. O. phot. 22/IX. 1933).

Mit Bezug auf die Regenbogenforellen brachten die Versuche das Ergebnis, (wenn auch nicht mit völliger Sicherheit), dass nur ca. 3 % der Grössengruppe 10—22 cm. beim Durchgang durch die Turbine beschädigt wurden. Von den grösseren Fischen von ca. 1 kg. schien die Hälfte lebend der Turbine entronnen zu sein.

2. Kraftstation von Vestbirk. (Versuch vom 22. IX. 1933).

Die Kraftstation (Fig. 6) verfügt über eine Fallhöhe von gut 9 Metern. Es sind dort zwei Turbinenkammern, jede mit einem wagerechten Turbinenaggregat von 900 PS. Jedes Aggregat besteht aus 2 Zwillingsturbinen (wie in Tange), sodass die Wassermenge, die eine

Turbinenkammer passiert, auf 4 verschiedene Laufräder verteilt wird, die auf derselben Welle sitzen (Fig. 7). In dem einen Aggregat können die Laufschaufeln der einen Zwillingsturbine unabhängig von der anderen geschlossen werden, sodass eine allein arbeiten kann. Die Turbinen sind Francisturbinen von der Firma "Verkstaden", Kristinehamn. Für jedes Laufrad sind 14 Leitschaufeln (Länge 267 mm., Breite 298 mm.); der grösste Durchmesser des Laufrades beträgt 780 mm.,

Fig. 10. Die Turbinenschleuse bei der Papierfabrik von Silkeborg, von einer Brücke über dem Hinterwasser aus gesehen. Der Fangbeutel ist an dem Rahmen befestigt und liegt bereit, um auf seinen Platz angebracht zu werden. Zur rechten vom Turbinenhaus sieht man einen Teil vom Stauwehr, zur linken den Bauplatz mit Gerümpel bis an das Hinterwasser hinunter. (C. V. O. phot. 23/VIII. 1935).

der kleinste 480 mm.; es hat 16 Schaufeln (Länge 350 mm.). Die Geschwindigkeit beträgt 375 Umdrehungen in der Minute.

Wie bei dem Versuch in Tange wurde ein viereckiger Trichter gezimmert, der mit seinem oberen Ende bis zum Deck über der Turbinenkammer reichte (Fig. 8), während das untere Ende zwischen zwei Leitschaufeln angebracht und dort sicher befestigt wurde. Die Öffnung zwischen den Leitschaufeln betrug während des Versuches 60 mm.; die Turbine (das ganze Aggregat) ging mit 375 Umdrehungen in der Minute und mit ca. 500 Kilowatt Belastung (ca. ¾ der Last), wäre die Turbine aber den ganzen Vormittag in Gang gewesen, würde das Hinterwasser höher gestanden haben, und dann wäre bei gleicher Belastung eine grössere Schaufelöffnung notwendig gewesen (die maximale beträgt 100 mm.).

Es wurde derselbe Fangbeutel wie in Tange benutzt (Fig. 9). Er wurde auf einen Holzrahmen angemacht, der in Falze in den zementierten Ausströmungsraum passte. Da dessen Boden nicht regelmässig war und der Rahmen demnach nicht genau in ihn hineinpassen konnte, wurde unter dem Rahmen, bevor er hinuntergelassen wurde, eine Lage Heidekraut angebracht; es ist begreiflich, dass solche Heidebündel recht gute Gewähr dafür bieten, dass Fische wie Forellen sich nicht unter dem Rahmen hindurch zwängen, während sich dieses für den Aal wohl denken lässt.

Bei den Versuchen wurden 51 Regenbogenforellen (15—20 cm.) benutzt, 53 Bachforellen (10—15 cm.) und 30 Aale. Diese letzten wurden vorher dadurch markiert, dass die eine Brustflosse abgeschnitten wurde.

Um 11.30 Uhr waren die Vorbereitungen beendet, und die Turbine wurde in Gang gesetzt. Die Fische wurden auf das Deck über den Turbinenkammern gebracht und in den Trichter geschüttet, und zwar 50 Forellen um 11.42 Uhr, 54 Forellen um 11.46 Uhr und 30 Aale um 11.50 Uhr. Um 11.55 Uhr wurde die Turbine gestoppt.

Bei Untersuchung des Fangbeutels wurden eine Menge Kaulbarsche gefunden, einige Flussbarsche und Plötzen (keine Brachsen, Uckeleien oder Zander). Diese Fische müssen innen bei den Saugröhren gestanden haben; wir hatten zwar vorher versucht, solche Fische herauszutreiben, indem ein Boot in der Ausströmungspforte gewesen war und ein Mann versucht hatte, durch Staken mit einem Ruder die Fische weg zu scheuchen — aber hinter die Saugröhren hatte er nicht kommen können. — Beim Untersuchen des Beutels wurden folgende Versuchsfische gefangen:

Regenbogenforellen: 22 lebende[1]) (ohne Schläge), 5 gequetschte und 11 partierte.

Bachforellen: 11 lebende[2]) (ohne Schläge), 5 gequetschte und 7 partierte.

Aale: 3 lebende, davon 2 unbeschädigt, der 3. leicht geschlagen (vermutlich lebensfähig).

In der Mittagspause stand auch die Turbine still und wurde dann um 14.00 Uhr wieder in Gang gesetzt; sie lief bis 15.45 Uhr und wurde dann gestoppt; der Beutel wurde untersucht. Wieder kamen einige Fische, die unter der Turbine gestanden haben müssen, zum Vorschein, sowie die folgenden Versuchsfische:

Regenbogenforellen:	2	lebende	
Bachforellen:	9	„	
Aale:	2	„	und 12 tote.

Um 16.00 Uhr wurde die Turbine wieder in Gang gesetzt und lief bis 17.00 Uhr. Bei Untersuchung des Beutels wurden wieder Fluss-

[1]) Wegen zu langsamer Untersuchung des Beutels gingen später 8 Fische ein.
[2]) Wegen zu langsamer Untersuchung des Beutels gingen später 9 Fische ein.

barsche, Kaulbarsche und Plötzen sowie 2 Gründlinge aufgenommen, von den Versuchsfischen die folgenden:

Regenbogenforellen:	2	lebende
Bachforellen:	2	„
Aale:	0	„

Der Fangbeutel hatte einen Riss bekommen. Sowohl aus diesem Grunde wie auch wegen der Tatsache, dass bei den beiden letzten Untersuchungen keine toten Forellen und bei der letzten Untersuchung auch kein toter Aal aufgenommen worden war, wurde der Versuch eingestellt.

Die Erklärung dafür, dass die toten Aale, die wir aufnahmen, alle erst bei der zweiten Untersuchung zum Vorschein kamen, ist sicher darin zu finden, dass die geschlagenen Aale an den Laufschaufeln hängen blieben und erst abfielen, als die Turbine gestoppt wurde; als sie dann wieder in Gang gesetzt wurde, wurden die toten Aale sofort in den Beutel hinein gespült. — Als der Versuch abgeschlossen war, wurde die Turbinenkammer entleert und die Turbine untersucht; es sassen keine weiteren Aale darin. Von den 30 Versuchsaalen wurden nur 5 lebende und 12 tote wiedergefangen; die übrigen 13 sind vermutlich am Leben geblieben und haben sich unten am Grunde bei den Saugröhren gehalten oder haben sich möglicherweise durch das Heidekraut unter dem Fangbeutelrahmen hindurch gebohrt; es können wohl auch tote Aale in stille Winkel gespült worden sein.

Stellt man das Ergebnis auf, findet man folgendes:

Von den 51 Regenbogenforellen von 15—20 cm. Länge wurden 42 wiedergefangen, nämlich 26 lebende und 16 tote. Zählt man die fehlenden 9 unter die toten, wird der Verlustprozent 49; rechnet man damit, dass die nicht wiedergefangenen 9 Fische noch lebten und sich drinnen bei den Saugröhren hielten, was bei weitem das Wahrscheinlichste ist, erhält man einen Verlust von 31 %.

Von den 53 Bachforellen von 10—15 cm. Länge wurden 34 wiedergefangen, nämlich 22 lebende und 12 tote. Unter der Voraussetzung, dass die nicht wiedergefangenen 19 Fische tot oder was am wahrscheinlichsten ist lebend sind, ergibt der Verlust 58 beziehungsweise 23 %.

Was die Aale betrifft, so kann man nur sagen, dass der Verlust mindestens 40 % beträgt und wahrscheinlich noch mehr. Es ist charakteristisch, dass die 5 lebenden Aale 33, 34, 42, 43 und 47 cm. massen, während die getöteten eine Länge hatten von 42, 46, 47, 48 48, 49, 49, 49, 53, 57, 58 und 61 cm. Es scheint demnach, dass für einen gewöhnlichen Blankaal die Aussichten, lebend durch eine dieser Turbinen zu kommen, sehr gering sind.

Wenn der Versuch ergab, dass der Verlust an Forellen von gewöhnlicher Abwanderungsgrösse (10—20 cm.) vermutlich um ⅓ — ¼ liegt — was unsere Erwartungen überstieg — muss man die Ursache suchen in dem verhältnismässig geringen Durchmesser des Laufrades und seiner grösseren Geschwindigkeit.

3. Papierfabrik von Silkeborg.

(Versuch vom 12—133. VIII. und 22—23. VIII. 1935)

Die Stauanlage der Papierfabrik von Silkeborg (Fig. 10) hat eine Fallhöhe von 1.7—2.3 Meter. Die Turbine ist eine Kaplanturbine, 1935 von "Verkstaden", Kristinehamn, geliefert. Der Durchmesser des Laufrades beträgt 2300 cm.; letzteres hat 4 Schaufeln und macht 107 Umdrehungen in der Minute; die Höchstleistung ist 375 PS. Die Turbine sollte alles Wasser brauchen können, sodass nur ausnahmsweise Freiwasser gegeben wird.

Fig. 11. Der Fangbeutel wird auf seinen Platz angebracht. Der Rahmen wird hochgehoben, um in den einen Falz in der Schleusenwand eingesetzt zu werden. Er ist oben mit einer Planke verstärkt. (C. V. O. phot. 23/VIII. 1935).

Die Vorbereitungen zum geplanten Versuch mit dem Durchlassen der Fische wurden am 12. August begonnen. Es wurde ein Rahmen für den Versuchsbeutel gezimmert sowie ein Kasten, um die Versuchsfische hinunter zu schütten.

Die untere Kante des Rahmens wurde gebildet von einem der Staubalken, die dazu berechnet sind, gegebenenfalls in einen Falz am hinteren Ende der Turbinenschleuse (Fig. 11) hinuntergelassen werden zu können; da sie hauptsächlich aus Eisen bestehen, sind diese Balken sehr schwer, und man sicherte sich somit, dass der Rahmen auf den Boden hinunter sank. Die drei anderen Seiten des Rahmens wurden aus 4″ × 4″ (ungefähr 10 × 10 cm.) Holz gemacht, aber es zeigte sich doch, dass der Wasserdruck so gross war, dass das obere Holz sich bog und um nicht zu brechen mit einer Planke verstärkt werden musste.

Der Rahmen war ca. 5.5 m. breit und ca. 3.5 m. hoch. Die Wassertiefe in der Schleuse betrug 2.75 m.

In der Turbinenschleuse selbst war der Boden zementiert und eben, sodass der Rahmen unten gut anschloss. Hinter der Schleuse war der Grund der Au sehr unrein, da nämlich bei der Fabrik gerade verschiedene Bauunternehmungen in Gang waren und entlang der Au hinter der Schleuse der Arbeitsplatz für die Zubereitung der Stangen für den Eisenbeton lag; man musste daher damit rechnen, dass der Grund der Au voll von altem Eisen und dgl. war. Versuche, ihn mit

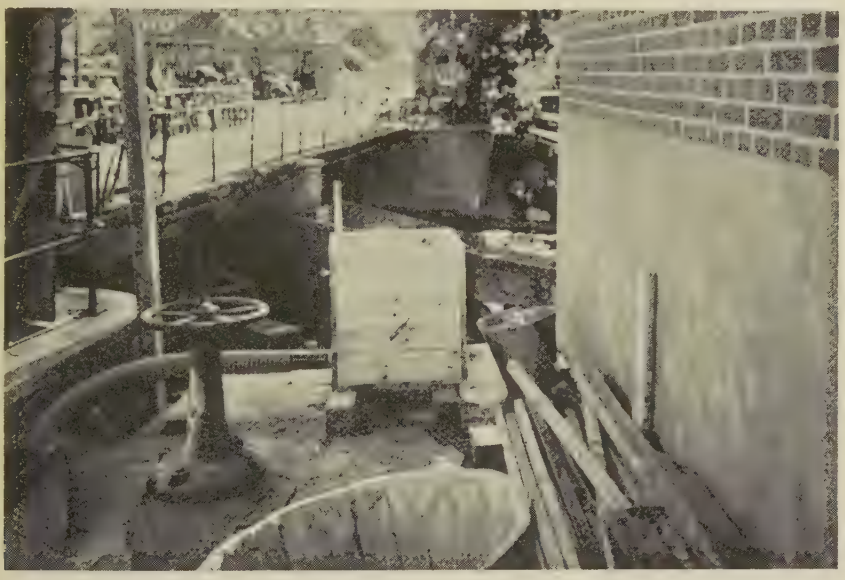


Fig. 12. Der Kasten zum Hinunterlassen der Versuchsfische. Der Schlauch geht unter dem Eisendeckel vorne links hinunter. Rechts die Mauer des Turbinenhauses. (C. V. O. phot. 23/VIII. 1935).

einer Harke zu reinigen, missglückten. Wir verschafften uns daher zwei grosse Eisenbahnpresenninge; der eine wurde auf der Unterseite des Rahmens festgeschlagen, der andere hinten angebunden; damit wurde ein grosser Teil des Bodens zugedeckt, sodass der Beutel auf dieser Strecke nicht reissen konnte.

Während es keinem Zweifel unterlag, wie der Beutel angebracht werden sollte, war es schwierig, die beste Art und Weise zu finden, um die Fische in die Turbine zu bringen. Um den Zugang von Luft in die Turbine zu verhindern, ist das Schleusendeck vor der Turbine extra verstärkt, sodass es in das Wasser hinunterreicht, und damit ist jeder Zugang, um (wie bei den anderen Versuchen) einen Trichter zwischen den Leitschaufeln anzubringen, ausgeschlossen. Es lag jedoch hinter dieser Verstärkung ein schmaler Schlitz mit einem Deckel

darüber (Fig. 12); durch diesen hinunter wurde ein Schlauch in Richtung der Turbine geführt, und die Ergebnisse während der Versuche zeigten, dass diese Anordnung für die Forellen genügte; es ist aber sicher vielen durch den Schlauch geschütteten Aalen geglückt, sich gegen den Strom von der Turbine weg zu retten.

Um die Versuchsfische in den Schlauch hinein zu befördern, wurde ein wasserdichter Kasten gezimmert, an den der Schlauch festgemacht wurde (Fig. 12); wenn dann ein kleines Schott hochgezogen wurde, lief Wasser und Fisch durch den Schlauch.

Am 13. August waren die Vorbereitungen beendet und die Versuchsfische wurden zu Wege beschafft. Zwei Tonnen mit lebenden Regenbogenforellen — 100 von 10—15 cm. Länge und 50 von 15—20 cm. Länge — wurden in die Nähe des obengenannten Kastens gestellt.

Der Rahmen mit Presenningen und Beutel wurde hinabgsenkt und die Turbine in Gang gesetzt. Es zeigte sich, dass sich in der Turbinenkammer eine grosse Menge von Abfall angesammelt hatte; der Beutel musste mehrere Male von Blättern und einer Menge grüner Äpfel geleert werden — aber schliesslich hielten wir ihn doch für genügend ausgespült.

(1.) Es wurden jetzt 25 Forellen von 10—15 cm. in den Kasten gezählt, und um 14.13 Uhr wurde das Schott gezogen, sodass die Fische durch den Schlauch in die Nähe der Turbine, wo die Saugkraft stark gewesen sein muss, hinunter gezogen wurden. Die Turbine lief mit voller Belastung und wurde eine Viertelstunde in Gang gehalten, worauf sie angehalten und der Beutel untersucht wurde. Der Ertrag war:

9 Regenbogenforellen.

Es war wieder viel Abfall in dem Beutel; ausserdem verschiedene am Versuch nicht beteiligte Fische (Barsche, Zander, Plötzen, Güster, Uckeleien), die in dem Ausströmungsraum gestanden hatten.

(2.) Um 15.00 Uhr wurden wieder 25 Forellen von 10—15 cm. in die Turbine hinunter gelassen, die mit voller Belastung lief. Nach ca. 5 Minuten riss der Beutel von der einen oberen Rahmenecke aus schräg nach unten, sodass das Unterteil ganz weggerissen und nach unten gespült wurde. Bei seiner Untersuchung fanden sich wieder viele Blätter und

24 Regenbogenforellen.

Von den 50 Versuchsfischen wurden also 33 Stück oder 66 % wiedergefangen, und keiner trug Zeichen irgendwelcher Beschädigung.

Die Reparatur des Beutels würde so viel Zeit beansprucht haben, dass es am besten schien, den Versuch abzubrechen.

Am 23. August wurde der Versuch wieder aufgenommen. Zunächst wurde gründlich ausgespült, um den Abfall weg zu bringen, denn dieser bedeutete eine grosse Gefahr für den Beutel, indem er die Maschen verstopfte. Der Beutel war inzwischen verstärkt durch vier der Länge nach laufende Leinen; beim Festmachen an den Rahmen wurde darauf geachtet, dass die Maschen, wenn sie nass wurden, nicht in den Rahmenecken spannten. Darauf wurde der Rahmen mit den

Presenningen und dem Beutel hinunter gesenkt und die Turbine in Gang gesetzt. Die Maschen waren aber doch verschieden stark gespannt und fingen längs den oberen Verstärkungsleinen sofort an zu springen, und die eine dieser Leinen riss. Es gelang, die Turbine zu stoppen, bevor der Beutel noch weiter riss, und durch eine kleine Änderung in der Festmachung der Verstärkungsleinen wurde ein gleichmässigerer Zug hergestellt. Doch schien das Risiko für ein erneutes Reissen des Beutels gross zu sein, und deshalb wurde beschlossen, alle Versuchsfische auf einmal in die Turbine zu schütten und sich damit zu begnügen, mit halber Belastung zu arbeiten.

(1.) Es wurden also 50 kleine Regenbogenforellen (10—15 cm.), 50 grössere (15—20 cm.) und 25 Aale (die vorher durch Kappen der einen Brustflosse markiert worden waren) in den Kasten getan und um 14.55 Uhr durch den Schlauch in die Turbine gelassen, die 10 Minuten lang mit halber Belastung lief. Darauf wurde das Ergebnis untersucht, es brachte:

41 kleine Regenbogenforellen — keine mit Schlagmerkmalen
24 grössere Regenbogenforellen — 1 zerschlagen
7 Aale, davon 2 mit Schlagmerkmalen.

(2.) Um 15.22 Uhr wurde die Turbine wieder in Gang gesetzt und lief 10 Minuten lang mit halber Belastung. Die Untersuchung ergab:

8 kleine Regenbogenforellen — keine mit Schlagmerkmalen
3 grössere Regenbogenforellen — keine mit Schlagmerkmalen
1 Aal — keiner mit Schlagmerkmalen.

(3.) Um wenn möglich noch mehr Aale heraus zu bringen, wurde die Turbine um 15.45 Uhr unter dreiviertel Belastung in Gang gesetzt und lief wieder 10 Minuten. Die Untersuchung ergab:

5 kleine Regenbogenforellen — keine mit Schlagmerkmalen
4 grössere Regenbogenforellen — keine mit Schlagmerkmalen
1 Aal, der indessen nicht markiert war.

(4.) Von 16.07 Uhr 10 Minuten lang mit dreiviertel Belastung wiederholt. Da die früheren Untersuchungen gezeigt hatten, dass Fische die hinten im Beutel standen, aber nicht die Kehle passiert hatten, bei der Untersuchung nach vorn gingen, wurde es dieses Mal versucht, den Beutel von vorne aus zu untersuchen, indem er etwas hinter dem Rahmen aufgenommen wurde; es ergab aber nur:

5 kleine Regenbogenforellen — keine mit Schlagmerkmalen
5 grössere Regenbogenforellen — keine mit Schlagmerkmalen

(5.) Da es sich offenbar nicht machen liess, die Aale bei Tageslicht zu fangen (vgl. die Erfahrungen vom Tange-Versuch), wurden die Versuche vorläufig eingestellt; bis Mitternacht stand die Turbine still, wurde dann wieder in Gang gesetzt und lief eine halbe Stunde lang mit dreiviertel Belastung. Der Beutel wurde am nächsten Vormittag untersucht und ergab folgendes:

1 kleine Regenbogenforelle — ohne Schlagmerkmal
1 grössere Regenbogenforelle — ohne Schlagmerkmal
1 Aal, markiert. Geschlagen.
93 Aale, nicht markiert. 32 mit Schlagmerkmalen.

Da es sich zeigte, dass der Beutel ein grösseres Loch bekommen hatte, konnte es nichts nützen, die Versuche fortzusetzen, aber diese hatten auch, wie es schien, soviel ergeben, wie man erwarten konnte.

Von den 100 angewandten Forellen wurden 97 wiedergefangen. Ausserdem wurde eine Regenbogenforelle von 26 cm. gefangen, die aber nicht zu den Versuchsfischen gehörte; dasselbe gilt möglicherweise auch von einer anderen von 22 cm., die aber mit gerechnet ist. Das Sortieren vor dem Versuch ist nicht sonderlich genau gewesen, denn unter den 97 wiedergefangenen Regenbogenforellen waren 60 unter und 37 über 15 cm. Nur eine dieser 97 Regenbogenforellen war von einer Turbinenschaufel getroffen worden, also nur ca. 1 %, was sehr wenig ist. Von den kleinen Forellen wurde keine getroffen, von den grösseren nur eine, was 2.7 % entspricht. Ob der Verlust grösser gewesen wäre, wenn die Forellen in die mit voller Belastung arbeitende Turbine gekommen wären, lässt sich nicht sagen, aber das Ergebnis wäre kaum sehr stark beeinflusst worden.

Von den 25 Versuchsaalen wurden nur 9 wiedergefangen. Die anderen sind vermutlich gegen den Strom gegangen, ehe die Turbine sie ergriff. Man würde vielleicht ein besseres Ergebnis erzielen, wenn man bei solchen Versuchen Blankaale benutzte, die dem Strom wohl etwas eher folgen als die hier verwendeten Gelbaale. Von den 9 wiedergefangenen Versuchsaalen waren 6 unbeschädigt (72, 51, 47, 46, 42, 39 cm.), 3 dagegen beschädigt (50, 47, 36 cm.); von diesen letzten trugen zwei den gewöhnlichen Schlag quer über dem Körper oder dem Schwanz, während dem dritten (47 cm.) auf der einen Seite des Kopfes Haut und Fleisch abgeschält worden war, sodass er kaum mehr lebensfähig war. Danach war der Verlustprozent 33, aber die Anzahl der wiedergefangenen Fische ist nun auch reichlich klein, und es lässt sich denken, dass ein Teil der unbeschädigten Aale durch das Loch in dem Beutel hinausgeschlüpft sind, was den Verlustprozent zu hoch machen würde.

Die 93 Aale, die nach dem letzten Versuch im Beutel gefangen wurden und nicht markiert waren, waren alle blank. Die Nacht war für ihr Wandern günstig gewesen, und es ist anzunehmen, dass alle diese 93 Aale die Turbine passiert haben, und zwar in dieser selben Nacht (und dass sie nicht wie die Gelbaale und die anderen Fische vom Hinterwasser her in die Turbinenkammer gegangen sind). Von diesen 93 Aalen waren 32 geschlagen worden (34 %), aber auch hier ist das Verhältnis sicher nicht ganz richtig, denn die geschlagenen Aale sind unzweifelhaft alle gefangen worden, während ein Teil der unbeschädigten Aale sehr wohl nach vorn in den Beutel gegangen sein können, wo sie dann das Loch gefunden haben, oder sie sind wieder zurück in den Ausströmungsraum gegangen. Man muss bedenken, dass die Blankaale nicht freiwillig bis in den hellen Tag und zudem bei Sonnenschein im Beutel geblieben sind.

Eine bessere Angabe für die Anzahl der beschädigten Aale bedeutet sicher der Fang in der etwas unterhalb der Turbine stehenden Reuse, wenn auch die gesunden Aale ebensowohl hier grössere Möglichkeit

haben, dem Fang zu entgehen, als die beschädigten. Der lokale Fischer sagte, dass in dieser Reuse durchgehends ein Fünftel der Aale beschädigt seien.

Es mag erstaunlich scheinen, dass die Turbine den Regenbogenforellen sozusagen keinen Schaden zufügt, dagegen ca. 20 % der Aale zu vernichten scheint. Der Unterschied ist so gross, dass er wohl nicht allein durch die grössere Länge der Aale erklärt werden kann; vermutlich bewegen die Aale sich in einer Art und Weise, die sie mehr ausgesetzt macht. Dass die Grösse eine Rolle spielt, steht fest; die 93 Blankaale gehörten zu den drei Gruppen: grosse Weibchen (frühere breitköpfige), kleine Weibchen (frühere spitzköpfige) und Männchen; das Ergebnis innerhalb dieser Gruppen war folgendes:

	Gewicht	Anzahl	Geschlagen Stückzahl	Geschlagen Prozent
1. Grosse Weibchen	1.25 kg. per Stück	1	1	
2. Kleine Weibchen	0.25 „ „ „	24	11	46
3. Männchen	11 Stk. per kg.	68	20	29

Wären die Silkeborger Aale nicht so klein gewesen, würde der Prozentsatz der beschädigten Aale unzweifelhaft noch höher gewesen sein.

Ausser den genannten Fischen wurden in dem Beutel noch einige gute schöne Zander gefangen, einige Barsche, Plötzen, Güster, Brachsen und Uckeleien. Ein einziger Brachsen war geschlagen und hatte also die Turbine passiert (der Zwischenraum zwischen den Stangen des Gitters vorne beträgt hier infolge besonderer Erlaubnis 6.5 cm.), aber die anderen Fische sind wahrscheinlich hauptsächlich vom Hinterwasser aus in die Turbinenkammer gekommen. Wie die Aale scheinen auch die Zander es vorzuziehen, tags über im Dunkeln zu stehen.

Die Versuche bestärken die Vermutung, dass die jungen Lachse und Forellen Turbinen mit grossem Durchmesser, wenigen Schaufeln und geringer Umdrehungszahl mit geringem Verlust passieren können, während Turbinen mit kleinem Durchmesser, vielen Schaufeln und schneller Umdrehung ihnen gefährlich sind. Ein Überblick beweist das deutlich:

Versuchsort	Durchmesser des Laufrades	Anzahl der Laufschaufeln	Umdrehungen per Minute	Prozentsatz der vernichteten jungen Forellen (10–20 cm.) konstatiert	die weggebliebenen incl.
Vestbirk ...	0.48—0.78 m.	16	375	27 %	54 %
Tange	ca. 1 m.	16	214	2.9 %	37.1 %
Silkeborg ..	2.3 m.	4	107[1])	1.0 %	4.0 %

[1]) Während des Versuches lief die Turbine mit halber Belastung.

Fischereimässig gesehen ist es daher ein Vorteil, wenn man anstelle eines Aggregates von 2 Zwillingsturbinen eine einzelne Turbine benutzt oder (wie in Silkeborg) zwei selbständige Turbinen mit einer grösseren ersetzt.

Für die Aale ist sogar die Passage durch eine grosse Turbine mit wenigen Schaufeln und langsamem Gang gefährlich. Man muss also versuchen, die Passage von Aalen zu verhindern, z. B. dadurch, dass man sie vor der Turbine fängt oder durch einem Aalgang um die Turbine herum leitet (F r i s c h h o l z : Anlage und Betrieb von Fischpässen. Stuttgart, 1924).

Nachdem ich in den beiden früheren Versuchsberichten (1931 und 1932) eine Übersicht über die bisherigen Versuche, Fische durch Turbinen gehen zu lassen, gegeben habe, scheint erst ganz kürzlich etwas neues darüber erschienen zu sein. In dem Dezemberheft 1935 des "Salmon and Trout Magazine" hat W. L. C a l d e r w o o d (Passage of Smolts through Turbines) über verschiedene Beobachtungen und Versuche an einer irischen und einer schottischen Kraftstation berichtet.

Die erste dieser Stationen liegt an dem Shannon und besitzt eine Fallhöhe von ca. 30 Meter; sie hat sowohl Francis- wie Kaplan-Turbinen, die bei einer Geschwindigkeit von 167 Umdrehungen in der Minute im ganzen 33,000 PS entwickeln. So wie die Verhältnisse liegen ist anzunehmen, dass viele abwandernde junge Lachse die Turbinen passieren, aber es scheint, dass weder tote noch lebende Fische unterhalb der Turbinen beobachtet worden sind. Sie scheinen also offenbar durch die Turbine keinen Schaden zu leiden.

Die andere Kraftstation ist Tongland am Dee-Flusse. Hier beträgt die Fallhöhe ca. 31 Meter, und von dem Stausee wird das Wasser durch eine geschlossene Leitung zu den drei Turbinen der Kraftstation hinunter geleitet. Es handelt sich hier um Francis-Turbinen mit 24 Leitschaufeln und 9 Laufschaufeln, die 214 Umdrehungen in der Minute machen; der Abstand zwischen den Laufschaufeln beträgt ca. 25—30 cm., der Zwischenraum zwischen Leit- und Laufschaufeln ist 25—45 cm. In der geschlossenen Leitung zum Maschinenhause ist ein Turm eingefügt, in dem das Wasser mit freier Oberfläche steigt. Es zeigte sich, dass die abwandernden Junglachse sich zu mehreren Hunderten in diesem Turm sammelten; dadurch, dass der Wasserzustrom gesperrt und das Wasser vom Turm und der geschlossenen Leitung geleert wurde, zwang man die Fische durch die eine Turbine. Dieser Versuch wurde zwei Mal wiederholt. Beim ersten Mal waren die Leitschaufeln nur wenig geöffnet, beim zweiten dagegen wurden sie ganz offen gehalten. Das Ergebnis wurde von einem Boot im Hinterwasser verfolgt. Beim ersten Mal kamen die Fische zusammen mit dem letzten Wasser und im Laufe von kurzer Zeit trieben zahlreiche ohnmächtige Fische an der Oberfläche; sie erholten sich aber schnell, nur mit Ausnahme von einigen, die geschlagen worden waren und anderen, die die Möven nahmen; der Gesamtverlust wurde auf

höchstens 4 % angeschlagen. Beim zweiten Versuch passierten die Fische die Turbine ohne in nennenswertem Mass Schaden zu nehmen, im ganzen waren vielleicht 16 Fische zu Grunde gegangen, aber sie hatten zu Hunderten, ja vielleicht zu Tausenden oben im Turme gestanden; sonderbarerweise wurden dieses Mal nicht annähernd so viele ohnmächtige Lachse beobachtet wie beim ersten Mal. Tatsächlich scheint nach diesen Erfahrungen die Passage durch die Tongland-Turbinen dem Lachsbestand keinen nennenswerten Schaden zufügen zu können.

Wie Gunnar Alm und L. Kreitmann rechnete auch Calderwood mit der Möglichkeit, dass die Fische beschädigt werden könnten durch den grossen Druckunterschied, dem sie beim Passieren durch die Turbinen ausgesetzt sind. Die Fische, die die Tongland-Turbinen passieren, sind im Laufe von wenigen Augenblicken Schwingungen von + 3 bis — 0.6 Atm. Druck ausgesetzt. Die Versuche, die Calderwood aus diesem Grunde anstellte und bei denen die Fische unter ständiger Beobachtung waren, zeigten indessen, dass die Fische den veränderten Druck überhaupt kaum bemerkten, in jedem Falle aber keine schädlichen Nachwirkungen spürten. Auch hat Alm (Fisk och turbiner. Svensk Fiskeri-Tidskrift, 1927) nicht beweisen können, dass Druckschwingungen irgend welcher Einfluss beizumessen ist, und Kreitmann (Ministère de l'Agriculture, Direction générale des Eaux et Forêts. Annales, fasc. 58. Paris, 1930) hat sogar bei seinen Versuchen die Fische plötzlichen Druckveränderungen von 20 Atm. ausgesetzt, ohne dass sie den mindesten Schaden davon getragen hätten.

Calderwood hat versucht, bei seinen Versuchen kleine Holzfische und gewöhnliche Holzplatten, wie sie die Gärtner zu Etiketten benutzen, anstelle von lebenden Versuchsfischen anzuwenden, aber das Ergebnis war nicht befriedigend und diese Methode ist nicht zu empfehlen. Am besten ist es, lebende Fische von der gewöhnlichen Grösse abwandernder Junglachse und -forellen zu benutzen. Calderwood irrt sich, wenn er meint, dass bei den dänischen Versuchen "Coarse fish" benutzt worden seien; zu allen Versuchen wurden Regenbogenforellen genommen, ein einzelnes Mal auch Bachforellen, und die entsprechen in Form und Bewegung Lachs und Meerforellen von gleicher Grösse.

Tuna Tagging.

By

H. C. Godsil,

California State Fisheries Laboratory.

THE California tuna industry is largely dependent upon the yellowfin tuna *(Neothunnus macropterus)* and the striped tuna or skipjack *(Katsuwonus pelamis)*. These two fish range coextensively over the eastern Pacific and constitute a single fishery. The larger tuna vessels pursue the fishery throughout the year, and in recent years have extended their range to the equatorial grounds of Central America and the Galapagos Islands. A preliminary survey of this fishery, conducted over the past two years, has shown what information is most essential to its intelligent administration and rational exploitation. Exceeding all else in importance is the nature of the stock upon which the industry draws. Is the supply from our extensive fishing area derived from a single, migratory population, roving seasonally from the equator to our latitudes, or from numerous, distinct, and smaller populations, each confined to a limited geographical area? Because existing data are inadequate, a tagging programme has been initiated to answer this vital question.

The nature of the fishery and the inherent difficulties of tagging tuna should govern the type of tag used. Considerable thought was therefore given to this matter, and the tag in use was finally selected because: it can be rapidly and easily applied; it minimizes injury to the fish; and in theory at least it should be readily recovered.

The tag consists of two parts. The first is a sterling-silver folded strap, 15 mm. in length, 4 mm. in width, and about 0.5 mm. in thickness. The prong on the one arm of the strap is designed to lock through a perforation in the other arm when the tag is applied. In this position there is approximately 2 mm. clearance between the two arms. The second part is a coloured, slightly concave, laminated celluloid disc, 14 mm. in diameter. The disc bears the legend and the number, both being protected by superficial laminations of celluloid. The prong of the strap penetrates a slot in the centre of the disc, so that the strap serves merely to attach the disc to the fish.

The two parts of the tag are applied in a single operation by means of a modified pair of standard 6-inch "long-nose" pliers. After the

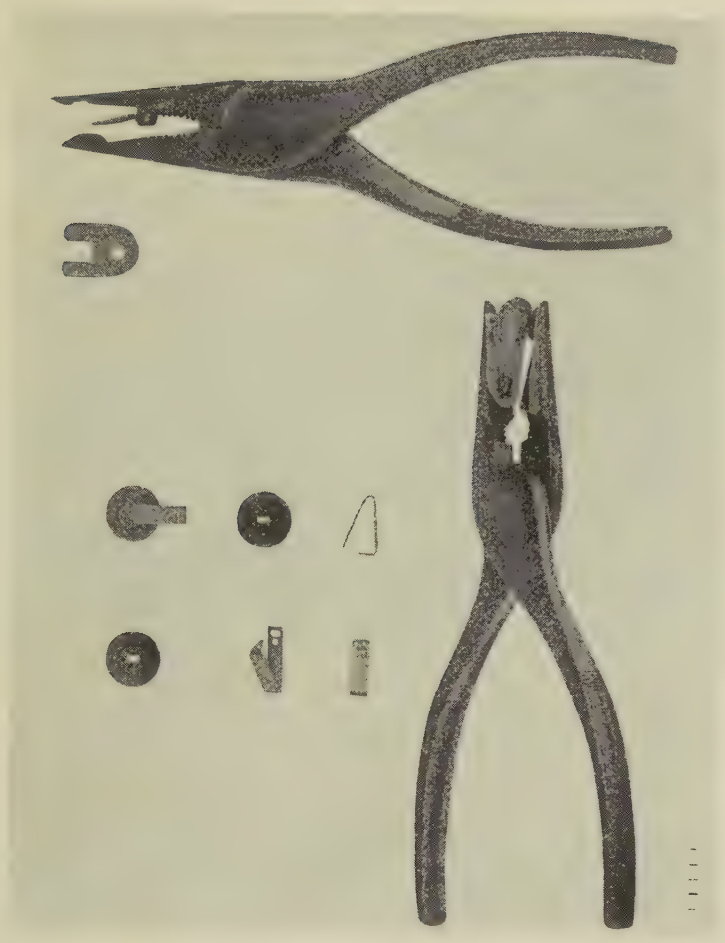


Figure 1. The tuna tag and the modified pliers used in attaching the tag to the fish. See text for description. (Photo by Hawthorne, February 1935).

jaws have been detempered they may be readily filed down as illustrated in the accompanying photograph, which shows, half natural size, the entire tagging assembly. The U-shaped piece shown attached to the jaw, and separately beside the pliers, is a piece of spring brass cut to shape and bent in such a manner as to hold the disc upon the strap during tagging.

In service, one or more pairs of pliers are loaded with a strap and disc and set aside in readiness, the number of the disc being noted. When a fish is caught and landed, the longer jaw of the pliers which carries the tag, and which is ground to a sharp edge for this purpose, is inserted below the preoperculum, carrying with it the straight arm

Figure 2. Catching tuna from a commercial vessel. The men fish from iron gratings suspended overside and land the fish in the alley between bait tanks and rail. The problem confronting the tagger is to find a place to work among the fishing crews yet clear of flying hooks and fish.

of the strap, until the angle of the strap comes within 3 or 4 mm. of the margin of the preoperculum (to allow for subsequent growth), when the tag is locked in place upon the preoperculum by pressure upon the handles of the pliers. The preoperculum is eminently suited to bear the tag, and was selected in preference to the operculum to eliminate possible injury to the gill filaments by the inner arm of the strap. The pliers are removed by spreading the jaws a trifle and lifting slightly on the handles, which, with the aid of the spring brass, serves to lift the perforated end of the strap from the slotted jaw.

With a little practice, a tuna may be tagged, measured, and returned to the water within 15 or 20 seconds. Experience has shown that most tuna, immediately after leaving the water, flex the tail and remain rigid after a momentary flurry, and remain thus flexed for perhaps a minute. It is in this interval that the tagging must be done, for when the ensuing struggle begins it is impossible to tag, and the fish, moreover, begins to bleed about the gills from the exertion. In a fast-biting school the pleasurable excitement of tagging these majestic fish is an experience long remembered.

The mode of fishing and the subsequent handling of the fish varies with circumstances. When operating from our own research vessels,

the fish are invariably caught by trolling lures with single, barbless hooks. The fish are hauled in and dropped into a canvas cradle in which they are tagged. This is the ideal method, but is rarely possible upon a commercial vessel, where the fish are caught with live bait and landed — while the fish are biting — at a rate approaching 20 or 30 tons per hour. Amid this confusion one must adapt one's tagging operations to existing conditions, as may be seen from the accompanying photograph. However, experience has shown that this may be done, and when satisfactory arrangements are made with the crew, this method offers perhaps the best available means of tagging tuna in large numbers. In an experimental trip to the equatorial grounds aboard one of the larger vessels, one man was able to tag no less than 575 fish.

The tagging programme has progressed slowly. In 1933, sample tags were made and tried upon dead fish. Later in the year a small order of tags was manufactured for further experiment, and in 1934 about 100 fish were marked and liberated. In this interval difficulties with the tags were overcome and necessary modifications made in the pliers. The tags and pliers herein described are not necessarily perfected, and improvements will be made as dictated by further experience. However, they are practical and sufficiently satisfactory so that in 1935 approximately 650 additional fish were tagged. With a larger supply of tags available, the California Division of Fish and Game is now embarked upon an extensive tuna-tagging programme with a goal of 10,000 fish in the immediate future.

The subsequent extension of this work will depend upon the returns from this experiment. Recovery of marked fish will be effected both by fishermen and cannery workers, and to facilitate the detection of these fish the celluloid discs are coloured a bright red. Several colours were tried, but the red proving the most conspicuous, will be used exclusively. Tuna are repeatedly handled individually, so that the chances of recovery are theoretically high. Moreover, a major proportion of the catch is handled in the canneries in such a manner that the right side of the fish lies uppermost upon the conveyors and tables, and in recognition of this fact all fish have been tagged upon the right side. The fishermen and industry have been advised of our programme, and their support elicited to insure the recovery of any marked fish taken. In the brief interval that has elapsed since the inception of this work, one tagged fish has been recovered, but that was taken only two days after marking in the same area where it was liberated, apparently none the worse for its experience. It is, however, premature to draw conclusions.

Coincident with this tuna-tagging programme, an attempt will be made to mark with the same tag a sufficient number of albacore *(Germo alalunga)* to reveal their migrations. A start was made in the summer of 1935, and about 70 fish were tagged and liberated. If fish and facilities are available, the work will be concluded in 1936.

Reviews.

G. Dietrich. "Aufbau und Dynamik des südlichen Agulhasstromgebietes." Veröff. Inst. f. Meereskunde. N. F., Reihe A, H. 27. Berlin, 1935.

The author has collected all available hydrographic observations from the area 27° S. to 50° S. and 0° E. to 40° E., and has, before starting his analysis, carefully eliminated data which appeared to be in error. Furthermore, he has determined the annual variation of temperature at depths of 100 and 150 m. in order to reduce observations from the upper layers to the same months. His amplitude at 100 m. lies between the amplitudes which have previously been determined by other authors in other regions.

In his further discussion the author assumes conditions to be stationary, and the fact that the greater part of the observations can be combined in a clear and simple picture forms the strongest support for the correctness of this view. The few series which do not fit into the simple picture indicate that disturbances occur, some of which appear to have the character of travelling eddies which are analogous to atmospheric disturbances.

One characteristic feature of the undisturbed system is that the greater part of the water which is carried by the Agulhas Current around the southern part of South Africa bends towards the south and east and returns again to the Indian Ocean in a high latitude. Not more than one quarter of the water carried by the Agulhas Current remains in the Atlantic Ocean.

Another characteristic feature is that the Agulhas Current is caused by the arrangement of light and heavy water masses, and is not a wind-driven current. At the surface it is, of course, modified by the prevailing winds, but on the whole it is a result of the internal field of force in the sea.

These features appear to be well established although the author expresses himself with great caution and admits that very few of his conclusions are free from hypothetical elements, but he hopes that new observations may help to throw light on several of the problems dealt with.

H. U. S.

H. Thomsen. "Entstehung und Verbreitung einiger charakteristischen Wassermassen in dem Indischen und südlichen Pazifischen Ozean." Ann. d. Hydr., usw. LXIII. Jahrg., H. 8. Berlin, 1935.

Thomsen's discussion is based principally on a study of T-S diagrams from stations in the western and northern Indian Ocean and the south-western Pacific Ocean. In the Indian Ocean Thomsen points out seven different water masses, but he deals extensively with three only: the bottom

water, the Antarctic intermediate water and the Red Sea water. The bottom water is formed by mixing of true Antarctic bottom water with Atlantic deep water; the percentage amount of the latter increases with increasing distance from the bottom. The Antarctic intermediate water can, in the western basin, be traced from about latitude 47° S. up to the equator, but the depth of the salinity minimum rises towards the north. The Red Sea water is found below the intermediate water at stations north of Madagascar.

These features have previously been more or less recognized; the essential novelty in Thomsen's conclusions is that he finds no evidence of the existence of a south-going deep water current between 2000 m. and 3000 m., which according to earlier investigations should be analogous to the deep water current in the Atlantic Ocean. The question of this deep current is not yet quite settled. In a recent paper[1]) Clowes and Deacon have published a section from the eastern Indian Ocean, based upon "Discovery II" observation in 1935. They find traces of a rudimentary south-going deep current extending to at least 35° S. Their conception of the deep water circulation is a compromise between the views of Thomsen and Lotte Möller.

In the southwestern Pacific Thomsen points out four different water masses and deals especially with the bottom water. He shows that warm deep water of relatively high salinity enters the Pacific Ocean through the opening to the south of New Zealand, and this deep water must come from the Atlantic Ocean, as previously assumed by the present reviewer. Thomsen considers the deep water in the southwestern Pacific as composed of three types of water: Antarctic bottom water, Atlantic deep water, and Antarctic intermediate water. He shows that the percentage amount of these three types varies systematically with depth and locality.

H. U. S.

V. Cornish. "Ocean Waves and Kindred Geophysical Phenomena." With additional notes by H. Jeffreys. Cambs. Univ. Press, Cambridge, 1934.

Dr. Cornish ist seit langem durch zahlreiche Aufsätze in Fachzeitschriften und vor allem durch sein früheres Werk "Waves of the Sea and other Water Waves" (London, 1912) als Wellenforscher bekannt. In diesem neuen handlichen Buch gibt er Ausschnitte aus seinen in fast vierzigjähriger Liebhaberarbeit gesammelten Beobachtungen zum Thema "Wellen", die dann grösstenteils in den "Additional Notes" durch H. Jeffreys mathematisch-physikalisch erörtert werden. In diesem Anhang, der etwa ein Viertel des Buches umfasst, liegt der wesentliche Unterschied gegenüber den "Waves of the Sea" und eine Ergänzung, auf die der Verfasser selbst, wie er im Vorwort ausführt, seit Jahrzehnten gewartet hat. Die Gruppierung des Stoffes ist im grossen die gleiche wie in dem älteren Buch (Ozeanwellen im Verhältnis zum Wind — Sand- und Schneewellen — Borenartige Erscheinungen in Flüssen); vor allem im zweiten Teil werden neue Beobachtungsergebnisse über Sandwellen (durch Wind wie durch Wasser erzeugte) und Schneewellen, dazu auch eigene Experimente des Verfassers mitgeteilt. Ein besonderer Vorzug des Buches für jeden, der sich Anleitung für eigene Beobachtungen holen will, ist die liebevolle Ausführlichkeit, mit der Dr. Cornish seine Beobachtungsmethoden, die

[1]) *Nature*, Vol. 136 p. 936—938, 1935.

sich immer der einfachsten Hilfsmittel bedienen, an Einzelfällen erläutert. So etwa im ersten Abschnitt, der den Leserkreis dieser Zeitschrift am meisten interessiert, die Auseinandersetzung über Täuschungen beim Schätzen grosser Wellenlängen (die infolge der Schwierigkeit, den Vorübergang des wirklichen Kammes zu erfassen, meistens unterschätzt werden). Besonderes Interesse werden auch die kritischen Mitteilungen über eigene und fremde Schätzungen grösster Wellendimensionen finden, unter denen Angaben über Höhen von reichlich 20 m. (Nördlicher Stiller Ozean) und von rund 25 m. aus dem Nordatlantischen Ozean für glaubwürdig befunden werden. (Diese letzte Angabe geht auf Schätzungen an Bord des Riesendampfers "Majestic" zurück, vgl. *The Marine Observer*, 1934, S. 105/08). Als besonderes Kennzeichen der Sturmwellen der zirkumantarktischen zusammenhängenden Weltmeerflächen (des "Southern Ocean" der Engländer) wird grosse Wellenlänge und — quer dazu — grosse Kammlänge, weniger aussergewöhnliche Wellenhöhe, hervorgehoben. Die Überschlagsrechnungen zu den Beobachtungen über Wind, Seeraum und Seegang werden manchen Leser vielleicht doch leise an eine Diskussionsbemerkung von G. Simpson zu ähnlichen Ausführungen des Verfassers erinnern, dass die gefundene Übereinstimmung zwischen Wind- und Wellengeschwindigkeit "zu gut erscheine, um wahr zu sein" (Quart. Journ. R. Met. Society, 1926, S. 127).

Das Buch ist durch eine grössere Anzahl ganzseitiger Abbildungen nach Aufnahmen des Verfassers geschmückt. Es stellt als Gemeinschaftsarbeit eines unermüdlichen Meisters der Beobachtung und eines Geophysikers eine dankenswerte Bereicherung der Literatur über Wellen dar.

A. Schumacher.

C M. Maldura. "Su l'unificazione dei metodi di analisi dei sali nutritivi e della silice in soluzione nell'acqua di mare." Boll. Pesca, Piscicol. e Idrobiol. Anno XI, Fasc. 3. Roma, 1935.

La Commission Internationale pour l'Exploration de la Méditerranée has proposed to study the biological stock of the Mediterranean in relation to the quantity of nitrates and phosphates in solution. Since the analyses of phosphates and nitrates made by Helge Thomsen on board the "Dana" showed that the Mediterranean is very poor in these salts, analytical methods may need to be even more sensitive than those we use in our northern waters. Maldura has therefore surveyed the literature and concludes that in general the existing methods are likely to suffice for such a study. While this may be so the small amounts present particularly in the eastern basin are likely to tax the skill of the analyst if a clear picture is to be obtained of the variations with place, depth, and season. Since the International Council for the Exploration of the Sea already has a Subcommittee charged with the task of preparing a report on this same subject, this seems a field where the two International Councils could collaborate to their mutual advantage. The greater transparency of the water and the greater intensity of the sunlight which enters the Mediterranean at an angle more nearly vertical than in our more northern waters suggest that chemical analyses made in conjunction with measurements of light penetration and of the vertical distribution of plankton organisms should prove of much value.

L. H. N. C.

A. Keys, E. H. Christensen and **A. Krogh.** "The Organic Metabolism of Sea-water with Special Reference to the Ultimate Food Cycle in the Sea." Journ. Mar. Biol. Assoc. N. S., Vol. XX, No. 2. Plymouth, 1935.

Pursuing their study of the dissolved organic matter in sea water, Krogh and his collaborators have approached the following two problems: "How great are the metabolic activities of bacteria in sea water under the various conditions of the laboratory?" "What bacterial activities may be inferred to take place in the sea itself?" They have paid special attention to the extent to which bacteria in sea water may utilize the dissolved organic matter which by means of Krogh's and Keys's methods they have shown to be generally of the order of 200 mg. nitrogen and 6 to 10 times that much carbon per cubic metre.

In non-sterile experiments with sea water stored in bottles out of contact with the air in the dark, an oxygen consumption was observed similar to that previously observed by Föyn and Gran. It was found to run roughly parallel to a bacterial multiplication which begins very suddenly after collection of the water. The number of bacteria was estimated from agar-plate counts on a glucose-peptone agar. The effects were greatest in untreated water, less in paper-filtered water and least in water which was doubly filtered through two thicknesses of the most retentive filter paper. When sea water was sterilized by filtration through a Zsigmondy collodium membrane filter, the oxygen content remained practically constant under the same conditions. These metabolic activities in the sea water samples were found to be self-limiting and stopped when there was still a large reserve of ammonia and oxygen and when only a small fraction of the dissolved organic matter had been decomposed. Assuming a respiration quotient of 0.85 the authors found that about 10 to 15 % of the total dissolved organic matter was destroyed, showing that this fraction was readily susceptible to biological degradation, provided the stimulus of handling the sea water in the laboratory was supplied. A great variety of sea waters was studied and they all possessed a great reserve of potential nutriment which suddenly came into service when what seemed very small alterations in the physical characteristics of the environment took place. The authors assume that this may happen in the sea at various times and places, but, in general, an equilibrium is maintained in which only a minimal bacterial population is supported by the dissolved material which is perhaps not wholly out of organic circulation, but certainly not ordinarily a major link in the ultimate food cycle in the sea.

The behaviour of the ammonia content in these experiments (determined by the method of Krogh) indicated that the ammonia content observed in sea water is a resultant of purely chemical actions tending to diminish the ammonia, and of biological forces in which both ammonia consumption and ammonia liberation by bacteria may be observed.

Experiments showed that bacterial activity in sea water is very sensitive to temperature and to alkalinity, and relatively independent of ammonia, nitrate and nitrite, and also oxygen above half-saturation. Lack of phosphate was found to be a limiting factor for the bacterial activity in harbour water, but not in deep ocean water, which has naturally a high phosphate content.

In water from the deep ocean the authors observed that when the water was not allowed to warm up, the oxygen consumption was much less than in some of the same water which was warmed to 22° C. for only a few hours and then was cooled to the same level as the other water. Even temporary

warming had a marked effect in producing conditions favourable to bacterial development and chemical decomposition in sea water.

Trygve Braarud.

H. W. Harvey, L. H. N. Cooper, M. V. Lebour and **F. S. Russell.** "Plankton Production and its Control." Journ. Mar. Biol. Assoc. N. S., Vol. XX, No. 2. Plymouth, 1935.

Die von Harvey 1933 vor Plymouth mittels eines Messnetzes ausgeführten Untersuchungen über den Pigmentgehalt des Planktons (vgl. Journ. du Conseil Bd. 10, S. 105) wurden 1934 an einer Station 5 SM. vom Lande bei 50 m. Tiefe fortgesetzt und durch Zählungen des tierischen und pflanzlichen Planktons erweitert. Der Phosphatverbrauch betrug von Mitte Februar bis Mitte April 6—8 mg. P/m.^{3}, von April bis August 3 mg./m.^{3}. In der zweiten Augusthälfte stieg der Phosphorgehalt, bis im September die Herbstwucherung der Diatomeen einsetzte. Aus während eines ganzen Jahres durchgeführten Lichtmessungen und aus Versuchen über die Sauerstoffproduktion bestimmter Diatomeenmengen binnen 24 Stunden in verschiedenen Tiefen liess sich unter Berücksichtigung der Temperatur die zu erwartende Pflanzenproduktion im Sommer und Winter berechnen. Die Pigmentbestimmungen stehen in gutem Einklang mit den Planktonzählungen bei Umrechnung auf "Diatomeen von mittlerem Zellinhalt". Der Phosphatgehalt des Phytoplanktons wurde mehrfach bestimmt. Die jahreszeitlichen Unterschiede der Pflanzenproduktion waren 1933 und 1934 im Grunde gleichartig, im einzelnen jedoch verschieden, z. T. wegen verschiedener Lichtverhältnisse. Die Menge des Zooplanktons wurde einerseits nach Zählungen, unter Berücksichtigung des Volumens der einzelnen Formen, andererseits nach seinem Phosphorgehalt bestimmt. Die Jahreskurven für beide stimmen gut zusammen. Die Zahl der Fäkalballen bezogen auf die Zahl der Copepoden und Copepoditen zeigt einen ähnlichen Jahresverlauf wie die Menge der pflanzlichen Nahrung nach Pigmenteinheiten.

Im Frühling ist die nachweisbare Menge des Phytoplanktons viel geringer, als man nach dem Phosphatverbrauch erwarten sollte. Diese Differenz ist, wofür auch die Ergebnisse von Boysen Jensen und Marshall und Orr sprechen, auf Tierfrass zurückzuführen. Manche Arten scheinen bei reichen Diatomeenbeständen weit über ihren Bedarf hinaus zu fressen. Die Grösse des Frühlingsertrages an Phytoplankton liess sich aus der Menge des verbrauchten Phosphats und dem Phosphorgehalt der Frühlingsdiatomeen berechnen, wobei der in drei Versuchsreihen nachgewiesene Phosphorgehalt der Diatomeen pro ccm. und die Erfahrungen mehrerer Jahre über den Phosphatverbrauch benutzt wurden. Die Berechnung des Diatomeenwachstums ergibt eine Zellteilung in weniger als 18 Stunden oberhalb von 25 m., während darunter im März der Lichtmangel keine wesentliche Photosynthese mehr zulässt. Der Phosphatgehalt des tierischen Planktons ist viel geringer, als man nach der Berechnung aus dem Diatomeenverbrauch erwarten sollte. Vermutlich werden beim Fressen der Tiere gelöste organische Phosphorverbindungen aus zerstörten aber nicht verdauten Diatomeen ins Wasser entleert, wo sie lange stabil bleiben. Die Sommerbevölkerung der Diatomeen ist wesentlich verschieden von der des Frühlings, teilweise schwach und unregelmässig verteilt, ohne dass jedoch die wohl dann auch Detritus fressenden Tiere an Nahrungsmangel leiden. Kulturversuche nach Allens Methode deuten darauf hin, dass das Wasser im Spätsommer reich an "Sporen" ist. Der Herbstwucherung der Diatomeen geht eine Zunahme des inzwischen regenerierten Phosphats und (wohl etwas später) des Nitrats

voraus. Die Dauer der Wucherung wechselt in den verschiedenen Jahren mit der Lichtmenge.

Die Arbeit stellt einen sehr interessanten Versuch dar, die Planktonproduktion an einer Stelle im Kreislauf des Jahres unter Berücksichtigung aller erkennbarer Faktoren quantitativ darzustellen. Unter den vielen Schwierigkeiten dieser Aufgabe erscheint als die grösste die, dass der Gehalt des Wassers an gelösten organischen Substanzen bisher nicht bestimmbar ist.

E. H.

P. Jespersen. "Quantitative Investigations on the Distribution of the Macroplankton in Different Oceanic Regions." Dana-Report No. 7. Copenhagen, 1935.

Diese Arbeit erstreckt sich auf Meeresgebiete von so grosser Ausdehnung, wie sie noch keine andere allgemeine Untersuchung über das Plankton umfasst hat. Mehr als 2000 Fänge der "Dana"-Expeditionen, ausgeführt mit Straminnetzen von $1^1/_2$—2 m. Durchmesser, werden inbezug auf das Volumen des Macroplanktons ausgewertet. Stets wurde die Zahl in ccm. für einen einstündigen horizontalen Fang berechnet, sodass lange Reihen von Fängen längs der Fahrtlinien oder für bestimmte Ausschnitte des Ozeans und für die verschiedensten Leinenlängen von 50—5000 m. miteinander quantitativ vergleichbar werden. Die Ergebnisse lassen überall deutlich die grossen Grundzüge der Dichteverteilung des Planktons erkennen, die bisher mit anderen Methoden nur bruchstückweise festgestellt worden sind.

Drei Profile über den Atlantischen Ozean zwischen 10° und 50° N.Br. (50—300 m. Drahtlänge) zeigen die Planktonarmut der Sargassosee, ein schwaches Ansteigen nach dem Caribischen Meer zu, stärkeres unmittelbar an der amerikanischen Küste, sehr starkes auf breiter Fläche an der Ostseite des Ozeans. Fänge bei Island und Grönland mit 1000 bis 4000 m. Drahtlänge zeigen Zunahme von Süden nach Norden. Fänge mit dem kleineren Netz zwischen etwa 8° und 55° N.Br. aus gleichen Tiefen erweisen im Norden dieselbe Zunahme, ferner Reichtum im Canarisch-Capverdischen Gebiet, äusserste Armut der westlichen Sargassosee. Die Fänge aus dem Stillen Ozean zwischen Panama und Australien (50—100 m. Drahtlänge) zeigen Reichtum des Planktons im Osten bis zu den Marquesas, hauptsächlich westlich der Galapagos, Armut südlich von Samoa zwischen Fijiinseln und Tahiti, weiterhin Zunahme gegen Australien und Reichtum bei Neuseeland. Ein Schnitt von Panama nach Neuseeland ähnelt infolgedessen den atlantischen Querschnitten. Im Einzelnen ist hervorzuheben, dass im Golf von Panama das Plankton unter 1000 m. viel reicher ist als über 1000 m., dass zuweilen, (doch nicht immer) Planktonreichtum und Reichtum an Phosphat und Nitrat zusammentrifft, dass im Westen die Temperatur sowohl durch ihre nordsüdliche Abnahme wie ihre ostwestliche Zunahme zwischen Neuseeland und dem Festlande Einfluss auf die Planktonmenge hat, und dass der Reichtum bei Neuseeland auf Zustrom antarktischen Wassers beruht. Die Anzahl der Fische in den Fängen des Stillen Ozeans zeigt in allen Abschnitten ein Minimum bei 1000 m. Drahtlänge, Maxima bei 50—300 und 2000 m. Das Minimum bei 1000 m. Drahtlänge ist auch im Planktonvolumen nachweisbar. Das Maximum bei 2000 m. (= 1000 m. Tiefe etwa) trifft mit dem Kern des "Subantarktischen Zwischenstroms" zusammen. Die Planktonvolumina des indo-malayischen Gebiets lassen trotz der Tropenlage jahreszeitliche Veränderungen erkennen. Westlich von Sumatra wurden so zahlreiche Fänge aus 200—350 m. Tiefe gemacht, dass Mittelwerte für 44 Eingradfelder berechnet werden konnten.

Im Indischen Ozean nimmt auf der Strecke Sumatra—Ceylon—Madagaskar —Mombasa das Plankton bis Madagaskar stetig zu, hauptsächlich durch Salpen bedingt, wird dann aber sehr gering, wie auch auf der ganzen Strecke Mombasa—Kapstadt. Die Strecke Kapstadt—Gibraltar zeigt bis St. Helena geringe Planktonmengen, danach starke, voneinander scharf getrennte Maxima, meist von Salpen gebildet, die deutlich den "Zungen" der "Meteor"-Expedition entsprechen. Ein reiches Material von der Gibraltarstrasse offenbart jahreszeitliche Unterschiede. Die meist vorherrschenden Salpen zeigen tageszeitlich gleichmässige Verteilung, Siphonophoren und Euphausiden dagegen nächtliches Aufsteigen. Im Mittelmeer nimmt das Plankton von Westen nach Osten ab, scheinbar in Korrelation mit dem Nitratgehalt. Ein Vergleich des Caribischen Meeres mit dem Golf von Panama ergibt für die oberen Wasserschichten reicheres Plankton im Westen, für die tieferen im Osten der Landenge und zwar bei 1000—3000 m. Drahtlänge das 6—8 fache. Nur hier unter allen befahrenen Strecken gibt es ein Überwiegen des Tiefenplanktons über das der obersten Wasserschichten. Zum Schluss wird eine graphische Gesamtübersicht gegeben.

Im Bereiche der geographisch gerichteten Planktonforschung nimmt diese Arbeit eine einzigartige Stellung ein, nicht nur durch die gewaltige Ausdehnung der untersuchten Meeresgebiete, sondern besonders dadurch, dass sie trotz der Einfachheit ihrer Methodik die grossen geographischen Verhältnisse der Planktonverteilung im Ozean, die auf anderen Wegen nur mit grosser Mühe festzustellen sind, augenscheinlich quantitativ richtig zur Darstellung bringt. Sie ist so rein quantitativ, dass lateinische Artnamen überhaupt nicht, auch Gattungsnamen so gut wie garnicht vorkommen.

E. H.

W. E. Frost. "Larval Stages of the Euphausiids *Nematoscelis megalops* (G. O. Sars) and *Stylocheiron longicorne* (G. O. Sars) taken off the South-West Coast of Ireland." Proc. Roy. Irish Acad. Vol. XLII, Sect. B, No. 16. Dublin, 1935.

Miss Frost adds two more larval histories to the series of euphausiids which she has investigated during the last few years. Both come from the deep water off the south-west of Ireland where the adults have already been recorded by Holt and Tattersall. The material was collected during the scientific cruises of the S. S. "Muirchu," the vessel of the Irish Free State Fisheries Department. The area investigated lies off the south and south-west coast of Ireland and extends from 51° 40′ N. in the north to 49° 20′ N. in the south, and 6° 21′ W. in the east to 12° 00′ W. in the west. A list of stations (19 in all) where the larvae were taken is given. The work is illustrated by four plates of clear line-drawings.

Neither of these larval histories was previously known, although those of *Nematoscelis microps*, *Stylocheiron suhmii* and *S. abbreviatum* have been described from the Mediterranean in the neighbourhood of Alexandria, where the waters although much shallower were of comparatively high salinity and temperature corresponding to the oceanic conditions of the Irish Sea. It is interesting to find that in all these species and in *Euphausia krohnii* and *Thysanopoda aequalis* previously described there is an abbreviation in the number of larval furcilia stages, showing a distinct shortening of the life history compared with the long series of larvae in those from the more neritic waters — *Nyctiphanes*, *Meganyctiphanes*, and *Thysanoessa*.

Miss Frost thinks it probable that *Stylocheiron longicorne* is able to reproduce throughout the year but with varying seasonal intensity. She finds in *Nematoscelis megalops* that the furcilia stages do not correspond with those previously found in *N. microps,* but that those of *Stylocheiron longicorne* agree with those of *S. suhmii* and *S. abbreviatum* from the Mediterranean except for the fact that in *S. suhmii* an extra furcilia stage was found.

M. V. L.

T. Braarud. "The Øst Expedition to the Denmark Strait 1929. II. The Phytoplankton and its Conditions of Growth." Hvalrådets Skr., Nr. 10. Oslo, 1935.

Die Arbeit wird eingeleitet durch eine theoretische Betrachtung über die Faktoren, welche die Zahl der Pflanzenzellen in der produktiven Wasserschicht bestimmen. Der Gegenstand kommt durch Betrachtung unter mehr oder weniger veränderten Gesichtspunkten in mancher Beziehung in neue Beleuchtung. Insbesondere treten als die Pflanzenbevölkerung schädigende Faktoren Tierfrass und Absinken sowie die teils schädlichen teils nützlichen Wirkungen der Turbulenz stärker hervor. Es werden direkte und indirekte Faktoren der Produktion unterschieden, von denen erstere die Zellenzahl, die Vermehrungsrate oder den Gehalt an organischem Material in den Zellen unmittelbar beeinflussen, letztere nur mittelbar durch ihre Einwirkung auf die ersteren. Ausser den Faktoren, welche für das Wachstum der einzelnen Algen selbst massgebend sind, wie Licht, Sauerstoff, Kohlensäure, Nährsalze, Temperatur, Salzgehalt, pH, wirken auf die Planktondichte als ebenfalls direkte Faktoren ein Tierfrass, Absinken und vertikaler Transport. Indirekte Faktoren sind beispielsweise Wasserbewegungen und Stabilität des Wassers, Zustrom aus Flüssen, Wetter, geographische und Tiefenlage. Der Verfasser bemüht sich besonders festzustellen, wie weit sich über das Ausmass der fördernden und hemmenden Wirkung der verschiedenen Faktoren etwas aussagen lässt.

Das Phytoplankton der "Øst"-Expedition im Juni bis August 1929 bestand aus quantitativen Centrifugenproben, bis 75 m. tief, die nach Grans Methode untersucht wurden, aus Netzfängen mit feinster Gaze und aus an und zwischen den Eisschollen gekätschertem Material. Neben dem Plankton wurden Sauerstoff, Phosphat und Nitrat untersucht.

Das Plankton zwischen Norwegen und Nordisland enthielt reichlich *Pontosphaera huxleyi,* in der Osthälfte auch *Rhizosolenia alata* und stellenweise *Syracosphaera dentata.* Es bewirkt im Juni starke, im August schwächere Sauerstoffübersättigung. In der Dänemarkstrasse herrschten an der Oberfläche vor im Osten *Thalassiosira,* in der Mitte *Nitzschia,* im Westen die mehr arktischen *Achnanthes* und *Fragilaria.* Bei der Untersuchung der Proben aus tieferen Schichten wurden TS-Diagramme nach Helland-Hansen angewandt, um die Mischungsverhältnisse der verschiedenen Wassersorten (polares Schmelzwasser, polares Zwischenwasser, atlantisches Wasser, arktisches Bodenwasser) festzustellen. Im dichten Packeis des Polarstroms fand sich hauptsächlich Flagellatenplankton, im offenen Packeis drei Typen von Diatomeenvegetation, gekennzeichnet durch (1). *Achnanthes, Fragilaria* und *Thalassiosira,* (2). *Thalassiosira gravida,* (3). *Detonula confervacea.* Der Irmingerstrom war arm an Diatomeen, reich an *Pontosphaera huxleyi.* Das Mischwasser ausserhalb des Polarstroms war sehr reich hauptsächlich an Diatomeen. Nach Netzfängen an der Küste und in den

Fjorden Ostgrönlands werden dort 6 Regionen unterschieden, die besonders durch die Mengenverteilung der Diatomeen und durch die vorhandenen Arten gekennzeichnet sind.

Die Planktonverteilung im eigentlichen Polarstrom der Dänemarkstrasse lässt sich entsprechend der Theorie Nansens derart deuten, dass nach Hervortreten des Wassers unter dem Eise auf einen Zustand mit reichlich Nährstoffen und wenig Plankton ein solcher mit wenig Nährstoffen und viel Plankton und schliesslich einer mit wenig Nährstoffen und wenig Plankton folgt. Der Nährstoffreichtum des Polarwassers stammt weder aus atlantischen Beimischungen noch aus sibirischem Flusswasser, sondern entsteht durch winterliche Konvektion im Polarmeer selbst. Unter den Faktoren der Pflanzenproduktion im Polarwasser dürften örtliche und zeitliche Unterschiede der Bewölkung von Bedeutung sein, dagegen die Zufuhr von Aussaatmaterial nicht in quantitativer Beziehung, sondern nur inbezug auf die Zusammensetzung der Vegetation. Die wenig untersuchte Pflanzenproduktion im arktischen Wasser am Rande des Polarstroms scheint so zu deuten zu sein, dass dort das atlantische Wasser die Nährstoffe, das Polarwasser die Keime geliefert hat, doch ist in späterer Jahreszeit (Meteor 1929) die Bedeutung der Bevölkerung des Polarwassers für dies Mischgebiet augenscheinlich geringer. Über die Bevölkerung des atlantischen Wassers lässt sich aus Mangel an Beobachtungen wenig aussagen. Die Darstellung der Planktonverhältnisse auf Grund von Centrifugenproben weicht naturgemäss von derjenigen auf Grund von Netzfängen ab, doch entsprechen — abgesehen von der Flagellatenvegetation des dichten Packeises und der *Detonula*vegetation der Dänemarkstrasse — die Planktontypen den früher beobachteten.

Es wird eine Liste aller Arten und ihrer Verbreitung mit systematischen Bemerkungen über sie gegeben.

E. H.

J. Le Gall. "Le hareng *Clupea harengus Linné*. I. Les populations de l'Atlantique Nord-Est." Ann. de l'Inst. Océanogr. N. S., Tome XV, Fasc. 1. Paris, 1935.

Nachdem die Zahl der Arbeiten über den Hering zu einer grossen Fülle angewachsen ist, die den Überblick erschwert, ist es für alle, die sich mit Forschungen am Hering beschäftigen oder sich auch nur dafür interessieren, von grossem Wert, eine Zusammenfassung zu haben, die alle wichtigeren Arbeiten auf diesem Gebiet berücksichtigt und vergleichend erfasst. Die vorliegende grosse Arbeit von Le Gall ist eine solche Zusammenfassung, die als solche nicht neue eigene Untersuchungen und Ergebnisse bringt, sondern welche die Ergebnisse aller bisherigen Untersuchungen nach verschiedenen Gesichtspunkten zusammenfasst.

Nach einleitenden Ausführungen über die systematische Stellung, Artcharaktere und Verbreitung des Herings werden in einem ersten Abschnitt die Arbeitsmethoden behandelt und in ihrer Anwendung bei den Untersuchungen der Heringe des östlichen Kanals und der südlichen Nordsee betrachtet. Diese Dinge werden sehr eingehend und ausführlich behandelt. Darunter nehmen besonders die Ausführungen über die Bestimmung von Alter und Wachstum einen grossen Raum ein. Der Abschnitt schliesst mit einer zusammenfassenden Betrachtung der Heringspopulationen des östlichen Kanals und der südlichen Nordsee. Im nächsten Abschnitt werden die Heringe der übrigen Gebiete der nordwesteuropäischen Meere im Einzelnen besprochen.

Die weiteren Ausführungen gelten den Umweltseinflüssen und der Verteilung der verschiedenen Populationen. Hierbei wird auch die von Le Danois aufgestellte Theorie von den atlantischen Transgressionen in den Kreis der Betrachtungen gezogen. Im übrigen wird der Einfluss von Temperatur und Salzgehalt auf die Zahl der Wirbel und Kielschuppen sowie der Einfluss wechselnder Umweltsbedingungen auf die Heringsschwärme besprochen. Schliesslich ist auch der Periodizität der atlantischen Transgressionen und ihrer Beziehung zu Schwankungen in der Fischerei ein Abschnitt gewidmet.

Eine ausführliche Zusammenfassung mit allgemeinen Schlussfolgerungen schliesst diese umfangreiche Arbeit ab, die durchaus einen kompilatorischen Charakter hat. Bei der Beurteilung des Wertes der verschiedenen Merkmale für die Unterscheidung der Rassen schliesst sich Le Gall der Ansicht derjenigen Autoren an, die bei den Rassenuntersuchungen das Hauptgewicht auf die Zahl der Wirbel legen, nicht zuletzt aus dem Grunde, weil, wie schon von anderer Seite betont ist, die Zahl der Wirbel bereits früh in der Entwicklung festgelegt ist. Damit und mit der Feststellung, dass der Charakter der Wirbelvariation, die Homogenität des untersuchten Materials vorausgesetzt, bei den einzelnen Gruppen auch bei jahrelangen Beobachtungen gleichartig ist, bekennt sich Le Gall in gewissem Sinne doch zur Rassentheorie. Schwierigkeiten bereiten hier jedoch immer noch die Verhältnisse im östlichen Kanal und in der südwestlichen Nordsee, wo auch vom Verfasser, übereinstimmend mit allen anderen Untersuchern dieser Gebiete, eine Mischung aus zwei Typen festgestellt wird. Es muss allerdings hervorgehoben werden, dass hier von einer Mischung von zwei "Populationen" gesprochen wird. Dieser Ausdruck ist sonst als Bezeichnung für eine biologische Einheit nicht üblich, sondern "Population" ist im allgemeinen die Bezeichnung für eine örtlich und zeitlich gegebene Individuengemeinschaft ohne Rücksicht auf die Herkunft der einzelnen Bestandteile. Der Verfasser hat damit eine wenig glückliche Wahl eines Ausdrucks getroffen in dem Bestreben, die Ausdrücke "Rasse" oder "Varietät" vorläufig noch zu vermeiden.

Unter der Bezeichnung "Atlantischer Hering" fasst Le Gall den "Atlanto-Skandischen Hering" und den "Hiberno-Caledonischen Hering" zusammen, zwei Gruppen, die gewisse morphologische und physiologische Eigenschaften gemeinsam haben. Es wird dabei die Ansicht vertreten, dass die Gruppe dieser "Atlantischen Heringe", die ihre Verbreitung in den Gewässern des nordwesteuropäischen Schelfgebietes haben, die phylogenetisch ältesten Heringe sind, von denen sich die übrigen Heringe ostwärts in die Nordsee und Ostsee und ihre Küstengewässer abgezweigt haben, eine Ansicht, die bereits von anderer Seite (Schnakenbeck) zum Ausdruck gebracht wurde. Alle Zusammenfassungen mehrerer Gemeinschaften zu grösseren Gruppen sind jedoch mehr oder weniger künstlich, da in Wirklichkeit die Übergänge gleitend sind. Als höchster Salzgehalt, den der Hering ertragen kann, wird ein Gehalt von 35 $^0/_{00}$ bezeichnet. Er ist damit in seiner Ausbreitung auf die Kontinentalgewässer beschränkt. Das atlantische Wasser ist aber in ständiger Bewegung, und der Hering passt sich diesen Schwankungen an. Es werden somit manche Schwankungen in dem Vorkommen und der Verbreitung der Heringe mit Veränderungen im atlantischen Wasser in Zusammenhang gebracht, mit den Tiefenströmen (Pettersson) und atlantischen Transgressionen (Le Danois). Vorläuftig wird dies allerdings nur als eine Hypothese bezeichnet. Das Verhalten des Herings zur Umgebung ist aber auch verschieden je nach dem Stadium, in dem sich der Hering in seinem Lebenszyklus befindet. Ein laichreifer Hering stellt sich anders zu seiner Umgebung

ein als ein ausgelaichter Hering. Gerade in dieser zusammenfassenden Betrachtung wird dem Leser zum Bewusstsein gebracht, wie viele Fragen noch der Lösung harren. Wenn auch keine neuen Ergebnisse vorgezeigt werden, sondern nur die Ergebnisse der bisherigen Arbeiten über den Hering, so wird eine solche Zusammenfassung und Gegenüberstellung aller Ergebnisse und offener Fragen doch bei weiteren Forschungen anregend wirken.

Schnakenbeck.

P. M. Hansen, Ad. S. Jensen and **Å. V. Tåning.** "Cod Marking Experiments in the Waters of Greenland 1924—1933." Medd. Komm. Danmarks Fisk.- og Havunders. Ser. Fiskeri, Bd. X Nr. 1. København, 1935.

Den äusserst bedeutungsvollen Markierungen von Dorschen bei Grönland ist von drei dänischen Forschern eine sehr interessante und vollständige Beschreibung gewidmet.

Es wurden in allem bei Westgrönland 6811, bei Ostgrönland 772 Dorsche markiert. An der Westküste wurde die Arbeit an einer grossen Anzahl von Lokalitäten von der Südspitze (60° N.) bis Egedesminde (68° N.) ausgeführt und zwar sowohl in den Fjorden wie an der Küste und auf den dieser vorgelagerten Küstenbänken, — bei denjenigen an der Ostküste nur in den inneren Gewässern bei Angmagssalik (66° N.).

Die markierten Fische waren von allen Grössen zwischen 35 und 140 cm., im Westen die meisten aber 70—90 cm., im Osten 55—75 cm.

Die Marken bestanden aus zwei runden Ebonitscheiben, die am Kiemendeckel mit Hilfe der Tåningschen Hohlnadel durch einen Silberdraht befestigt wurden. Die Fische wurden in den meisten Fällen mit Handleine beschafft.

Eine Fülle von klaren Karten und detaillierten Tabellen gestattet dem Leser ein selbständiges Urteil über die Folgerungen, welche die Verfasser aus den 405 Wiederfängen ziehen.

Das wichtigste Ergebnis ist die grosse Abwanderung laichreifer Fische nach Island, wo sie bis auf acht Jahre nach der Aussetzung wiedergefangen wurden. Von den genannten 405 Wiederfängen wurde fast die Hälfte (197) bei Island gemacht. Sehr bemerkenswert ist es aber, dass dieser Wanderungsweg erst in den letzten Jahren eingeschlagen worden zu sein scheint, denn von den in 1924 markierten Fischen (28) wurden nur 8 %, von den in 1929 markierten (33) dagegen 63 % bei Island gefangen (die übrigen 92, bezw. 37 % bei Grönland), — im Jahre 1933 fielen sogar 72 % der Wiederfänge bei Island. Bemerkenswert ist ferner das Ausbleiben von Wiederfängen aus andern Gebieten als Island—Grönland.

Interessante Folgerungen werden auch gezogen über Alter und Reifung der wiedergefangenen Fische.

Die Verfasser finden, dass die Ergebnisse zu einer regelmässigen Forsetzung der Markierungstätigkeit sowohl wie einer kontinuierlichen Kontrolle der ozeanographischen Verhältnisse im Gebiet Grönland—Island berechtigen.

Die dänischen Fischereiuntersuchungen sind mit dem sowohl in technischer wie in wissenschaftlicher Hinsicht schönen Erfolg dieser Arbeit zu beglückwünschen.

Oscar Sund.

C. F. Hickling. "The Hake and the Hake Fishery." The Buckland Lectures for 1934. Edward Arnold & Co., London, 1935.

L'auteur, à qui on doit des progrès remarquables dans la connaissance de l'historie naturelle du merlu autour des Iles Britanniques, s'adresse dans cet ouvrage non seulement au public spécial des armateurs et des pêcheurs mais aussi à tous ceux qui s'intéressent aux problèmes de l'exploitation rationelle de la mer. Il a très bien réussi à présenter, objectivement et avec clarté, quelques-uns des aspects les plus importants de l'état actuel de la pêche du merlu en Grande Bretagne; en même temps l'auteur fait une défense, avec des arguments bien fondés, des mesures pratiques ayant pour but la conservation des stocks de ce poisson.

Le premier chapitre, comprenant l'exposé de certains faits de la biologie du merlu, tels que l'alimentation, la reproduction, la croissance et les fluctuations dans la composition des stocks de cette espèce, n'est qu'une sorte d'introduction aux questions principales que l'auteur s'est proposé de traiter, semble-t-il, dans ses conférences. Sous ce point de vue, on doit souligner plus particulièrement la corrélation assez nette qu'il a trouvé entre le produit de la pêche du merlu de petite taille (moyenne de la capture par jour d'"absence" des bateaux) et la température moyenne de la mer au bateau-phare de "Seven Stones" cinq ans auparavant. Cette corrélation, qui se base sur les donnés pour la région au sud et sudouest de l'Irlande, est interprétée par l'auteur comme étant due à l'effet favorable de la température plus élevée des couches superficielles de la mer sur la survivance des larves et des alevins du merlu pendant leur première année d'existence. D'autres facteurs jouent évidemment leur rôle plus ou moins marqué, et parmi eux l'auteur signale, par exemple, l'influence de la dérive des couches superficielles de la mer dans la région, qui peut transporter en plus ou en moins grand nombre et plus ou moins vite, les masses de jeunes merlus vers les endroits plus ou moins favorables à leur croissance ultérieure.

Les deux chapitres suivants sont consacrés spécialement à la pêche, non seulement au point de vue de l'histoire de son passé mais aussi de son état présent. La documentation statistique utilisée par l'auteur est très heureusement complétée par d'autres renseignements indispensables à l'éclaircissement de la question. La conclusion de son étude, c'est que la tendance générale depuis longtemps se dirige vers une diminution graduelle et constante, sauf quelques exceptions dans la période d'après-guerre, de la capture de merlu par unité d'effort, diminution qui est marquée surtout dans le cas des tailles les plus grandes. L'auteur s'occupe aussi des prix marchands et de leur variation, et les considérations faites sur la "demande" du merlu en Angleterre doivent être soulignées somme étant trés intéressantes. Le rôle de cette "demande" constitue évidemment un facteur important dans l'appréciation des mesures pratiques tendant à corriger les conséquences de l'exploitation excessive des stocks, comme l'auteur en fait la démonstration. Le troisième chapitre traite plus spécialement de ces mesures, de sa justification technique et économique, aussi bien que des résultats qu'on peut espérer de son application généralisée. Elles sont constituées, en somme, par l'élargissement des mailles des chaluts et l'établissement d'une taille marchande minima, toutes les deux calculées de telle façon qu'on puisse arriver à éviter autant que possible la capture ou la destruction inutile des jeunes poissons et, ainsi, que ceux-ci puissent avoir une plus grande chance d'atteindre la taille commercialement avantageuse. L'auteur expose, finalement, son procédé de prévision des résultats globaux de la pêche en certaines régions, procédé qui est basé sur la corrélation déjà mentionnée et sur l'interprétation des résultats de la

pêche des années immédiatement précédentes. Les faits, tout au moins pour le cas des prévisions données par l'auteur dans cet ouvrage, sont assez remarquables et bien animateurs.

A. R.

G. Duncker und **E. Mohr.** "Die nordeuropäischen Ammodytes-Arten des Hamburger Zoologischen Museums." Zool. Anz. Bd. 110, Heft 7—8. Leipzig, 1935.

Following upon the recent discovery of a new species of *Ammodytes* in Scottish waters (*A. marinus* Raitt, *Journal du Conseil*, Vol. IX, No. 3, 1934), these authors revised the sandeel material in the Hamburg Museum. The collection was found to include *A. lanceolatus, A. marinus,* and *A. tobianus.* The specimens of *A. marinus* had mostly been labelled *A. tobianus.*

The specimens of *A. lanceolatus* were from the North Sea to the north of Heligoland, Heligoland itself, the mouth of the Elbe, and the western Baltic. They had been taken not only on sandy ground in shallow water but also at greater distances from the coast at depths up to 60 m.

The specimens of *A. marinus,* 59 in number, were from the North Sea to the north of Heligoland and the southwest of the Turbo Bank, from Norway, the Murman coast, Greenland, America, and west Africa. As far as information is available, none of the North Sea material came from inshore waters. No material from the western Baltic or from the waters around the Danish islands was included in the collection. The specimen from America had previously been labelled *A. americanus* DeKay. The specimen from Greenland had been presented as *A. dubius* Reinhardt by Steenstrup in 1856. The Murman coast material consisted of 15 specimens of from 65 to 84 mm. in length. There is no element of doubt as to the origin of the west African specimens, which were 28 in number and in very good preservation.

The specimens of *A. tobianus,* 34 in all, came from the western Baltic, the mouth of the Elbe, Heligoland sands, and the North Sea.

Identifications were based upon numbers of dorsal, anal, and pectoral fin rays, the counting of vertebrae being impossible since the material had to be retained intact. In addition, however, the number of transverse body-striae was counted, establishing that character for the first time in the case of the species *A. marinus.* In *A. marinus* they numbered 139 to 155 and in *A. tobianus* 120 to 137.

In the opinion of the reviewer the identifications of *A. marinus* from America, Greenland, the Murman coast, and west Africa emphasize very strongly the need for an immediate revision of the entire family.

D. S. R.

K. Bahr. "Der kleine Sandaal (*Ammodytes tobianus* L.) der Ostsee." Zeitschr. Fisch. u. d. Hilfswiss. Band XXXIII. Berlin, 1935.

The work upon which this recently published paper is based was completed in 1933 and formed the subject of the author's thesis for the degree of Doctor of Philosophy of the University of Königsberg.

An introductory section deals with the systematic position of the species under consideration (*Ammodytes tobianus* L., the lesser sandeel), its general distribution, its importance in fishery economics, and the times and methods

of its capture in Baltic waters. The body of the publication is concerned with the time at which spawning takes place, together with a study of age determination, age, and growth, by means both of scales and of otoliths. A short account of the sandeels of the waters of Finland is appended for purposes of comparison.

As regards the spawning time of the lesser sandeel in the Baltic, his conclusions are as those of earlier workers upon the subject. He finds, as is on record both from the Baltic and the North Sea, that reproduction takes place in spring and again in autumn. He considers that these two spawning periods are probably not sharply separated from one another but overlap. He observes, as is also on record elsewhere, that autumn spawners are to be found close inshore while in spring ripe fish are located in deeper, offshore water.

He was successful in reading the ages of his specimens both from their scales and their otoliths. The former proved the more suitable. He gives the size ranges of fish of different ages. From age investigations upon ripe specimens he notes that, as a rule, the species spawns for the first time in the third growth-period. The average age of the stock is low. The majority of an age-class has disappeared by the end of its fourth year of life. Rate of growth is particularly strong during the first two years. In the third and fourth it slows down, to rise again perhaps in the fifth, one reads with some surprise, according to the few specimens of that advanced age in his material.

In a postscript to his paper he refers to the publication of an account of the sandeels of Scottish waters by the reviewer in 1934 (*Journal du Conseil*, Vol. IX, No. 3, that is to say in the interval between the completion of Bahr's investigations and their appearance in print. Therein a new species *Ammodytes marinus*, is described, closely resembling *A. tobianus* in usual characteristics but differing outstandingly from the lesser sandeel in fin ray and vertebral numbers. Their distributions and periods of reproduction are also distinct. It is *A. marinus* which spawns in spring and *A. tobianus* which spawns in the second half of the year.

B a h r, however, disagrees with the recognition of these as separate species. He cites the work of S c h n a k e n b e c k on the race question in fishes (Zeitschr. f. Morphol. u. Ökol. d. Tiere, Bd. 21, H. 3/4, 1931) as precluding the establishment of species on account of differences only in numerical characteristics, and, without further consideration, he adopts the explanation that *marinus* is a geographical race of *tobianus*, analogous to the geographical races of the herring. But, it must be remembered, the extent of differences in numerical characteristics also enters into the problem of races and species, apart from the fact that there are other points of distinction between the two forms in question. The numerical characters of *A. marinus* and *A. tobianus* are so widely separate that those of *A. lanceolatus* and *A. cicerellus*, two species of unquestioned authenticity, are intermediate between them. There is no such parallel in the case of the herring, where the maximum difference between the mean numbers of vertebrae of spring and autumn spawners in the northeastern Atlantic is about 0.7. That between *A. marinus* and *A. tobianus* is 5.8 with no overlapping of respective ranges.

Since, moreover, in his age analyses B a h r failed to distinguish in any way between spring and autumn-spawning specimens the greater part of his paper is to be taken with due reserve.

D. S. R.

H. O. Bull. "Studies on Conditioned Responses in Fishes. Part III. Wave-length Discrimination in *Blennius pholis L.*" Journ. Mar. Biol. Assoc. Vol. XX, No. 2. Plymouth, 1935.

"Part IV. A note on a sound-insulated building erected for the purpose of these experiments." Dove Mar. Lab. Rep. 1934. Newcastle-upon-Tyne, 1934.

"Part V. On the Controlling Influence of Normal Behaviour Traits upon Capacity to Form Experimental Conditioned Motor Responses under Certain Conditions." Journ. Mar. Biol. Assoc. Vol. XX, No. 2. Plymouth, 1935.

Continuing his experiments, described in the former numbers of this journal, the author has now changed his technique, in so far as no more food is used as a reward in the conditioning of his animals to visual stimuli, but the light stimulus is followed by an electric shock, as in his opinion the reaction to an electric shock is of a more truly reflex character than the response to food. The prime object of the first of these papers is to ascertain whether the electric shock is as appropriate for the investigation of sensory discrimination as the reward of food. Light stimuli of different wave-lengths, obtained by using gelatine filters in a light box, were at first always followed by an electric shock, but after a number of trials, different for the different subjects, soon the light alone evoked the bodily movements originally caused by the electric shock. Then other colours were applied to study the animals' colour discrimination. In all 9 *Blennius pholis* were studied for different combinations of colours (white against green, green against magenta, etc., and also different intensities of a natural grey) and, except when greys with too little difference of intensity were compared, positive results were always obtained. The results obtained in these discrimination experiments are summarized in a table.

While the second paper gives a short description of a sound-insulated building erected for carrying out these experiments under more constant conditions, the third reports the first results of the work done in this laboratory. In these a remarkable difference between some pleuronectids and other fishes appeared. Three specimens of that family (a *Rhombus maximus*, a *Pleuronectes platessa* and a *Pleuronectes flesus)* were seemingly incapable of forming an association between a visual stimulus (a circle of magenta light) and an electric shock in about 200 experiments, while six other fishes formed the same association in 16—37 experiments. On the other hand, as the author had formerly shown, when food is given as a reward, an association may very well be formed even in pleuronectids. The explanation of this difference must be, as the author himself says, that pleuronectids are so well adapted to their background that the normal reaction to danger is to keep still when alarmed. This fact, in my opinion, seems to prove that the reactions the author obtains with his electric shock are not of so truly a reflex character as he believes, but are instinctive flight reactions, associated in these experiments with the perception of the coloured light. This seems to me to be a more simple and true explanation of the facts than the author's conclusion that "normal behaviour traits control the *ability* of the fishes to form conditioned motor responses". From a biological point of view "keeping still" can as well be a "motor response" as swimming away is.

J. A. Bierens de Haan.

J. A. Kitching, T. T. Macan and **H. C. Gilson.** "Studies in Sublittoral Ecology. I. A. Submarine Gully in Wembury Bay, South Devon." Journ. Mar. Biol. Assoc. N. S., Vol. XIX, No. 2, p. 677—705 Plymouth, 1934.

Die schwer zugängliche Zone unmittelbar unter der Niedrigwasserlinie wurde mit dem Taucherhelm von den Verfassern untersucht. Der bisher nur in den Tropen verwendete Helm erwies sich bei ruhigem Wetter auch an der englischen Küste als brauchbar. Einzelheiten der Arbeitsweise und der Ausrüstung werden angegeben. Der erste Bericht über diese bemerkenswerten Versuche behandelt ein grosses unterseeisches Felsenloch (gully) in der Nähe von Plymouth, dessen Bewuchs an Algen und festsitzenden Tieren mit den darauf lebenden weniger beweglichen Tieren beschrieben wird. Ausführliche Tabellen am Schluss der Arbeit sind besonders für Vergleiche mit anderen Gegenden von grossem Wert. Besonders hingewiesen sei auf den Querschnitt auf S. 683.

Die Bedingungen des Lebensraumes werden erläutert, auch Lichtmessungen wurden angestellt. Die Besiedelung ist in hohem Masse von der Böschung des Felsens abhängig. Auf den senkrechten und überhängenden Flächen wachsen keine grösseren Algen, sie sind mit einem Polster der Ascidie *Distomus variolosus* oder des Schwammes *Halichondria panicea* bedeckt. Dagegen befindet sich auf den flachen Hängen ein üppiger Wald von Laminarien. Nach biozönotischen Gesichtspunkten werden die beiden Gemeinschaften, die "*Laminaria* forest association" und die "*Distomus-Halichondria* association" eingehend in ihren verschiedenen Schichten beschrieben. Schliesslich erörtern die Verfasser die Beziehungen der einzelnen Untergemeinschaften zu den äusseren Bedingungen. Sporen und Larven einiger Arten können sich wahrscheinlich nicht an überhängenden Felsen ansiedeln, der Schlickfall am Grunde verhindert das Gedeihen von Ascidien und Flächenschwämmen und die Lichtmenge begrenzt das Vorkommen und Gedeihen von Algen. Die Seepocken zeigen eine grosse Anpassungsfähigkeit, können aber nur dort wachsen, wo sie nicht von anderen Tieren oder Algen überwuchert werden.

A. H.

H. F. Prytherch. "Scientific Methods of Oyster Farming." Sci. Monthly. Vol. XXXVIII, pp. 118—28. New York, 1934.

This paper reviews the improvements in the American oyster industry brought about by scientific research. Of the three species of oysters cultivated in America, the most important is *Ostrea virginica*, which occurs naturally on the Atlantic and Gulf coasts, and comprises 99 % of the annual yield. After a brief résumé of the history of the American oyster industry, the author takes each stage in the culture of the oyster, and details the contributions of science to its better understanding and exploitation. Dealing with the fecundity of the oyster, the author claims that each oyster will produce one hundred to five hundred million eggs per season. Compared with the number of larvae (approximately $1^1/_2$ millions) produced by the British native oyster *(O. edulis)*, this estimate seems excessive. It has been shown that the spawning of the American oyster is influenced by temperature and the mutual stimulation of the sexes. The shedding of sperms by the males is stated to occur at 20—24° C., and is said to stimulate the spawning of the female, which otherwise occurs only at temperatures of 24.5° C. or higher. The exact significance and inter-relationship of these facts is still

in dispute. However, the establishment of breeding stock in warm bays and creeks is a practical application of these findings. The ability to forecast the time of spawning, which can be done with considerable accuracy, is of great value to the oystermen in determining the most propitious moment for planting out cultch.

The author describes briefly the process of setting, together with the necessary conditions. Much suitable oyster ground has been depopulated by pollution and overfishing, and this can be rehabilitated by the establishment of spawning beds, and the collection of seed. The overcrowding of spat constantly experienced in the best setting areas has been eliminated to a great extent by the development of artificial collectors. By the use of wire bags containing shells, partition collectors, brushwood, etc., the yield of seed oysters from a given area of bottom may be increased ten to fifteen times. Since it has long been recognized that intense setting occurs only in certain limited areas, the planting of these artificial collectors in such areas has become of considerable importance to the industry. Artificial collectors have been shown to be very satisfactory for use on soft mud where cultch would be quickly smothered. The extra labour entailed in separating the spat from the collectors, when a few months old, is stated to be well repaid by the superior growth and shape of such singled oysters. The transport of seed to the best growing grounds is also facilitated. On the Pacific coast, near Olympia, the oyster grounds have been much improved and extended by the construction of a system of dykes, dividing the foreshore in one-acre ponds. Such operations are expensive, but stated to be profitable.

Research has revealed that an oyster may filter as much as 15 gallons of water per day, and this fact should be borne in mind when considering the density of growing oysters per unit area of bottom.

The institution of sanitary standards for shellfish, and the possible good effects of purification are noted.

The process of shucking oysters is, at the moment, receiving the attention of scientific workers. Treatment with a very weak acid in fresh or salt water is stated to narcotize the oyster sufficiently to allow rapid opening, but it is very unlikely that such drastic treatment with chemicals will ever commend itself to the trade.

H. A. C.

A. W. H. Needler. "Rearing separate oyster spat on trays." Biol. Board Canada. Bull. No. XLVIII. Ottawa, 1935.

This paper contains a concise account of a method of rearing young oysters which has been successfully employed at the Prince Edward Island Biological Station, and which eliminates the heavy losses due to starfish which are experienced when oysters are reared entirely on the bottom. The losses due to starfish during the first and second years are generally estimated as exceeding 75 %. Losses due to this cause after the second year are almost negligible. This account is designed as an aid to the practical oyster-grower, and throughout details are given of the methods of construction of trays etc., and the cost of materials and labour. This method utilizes spat caught on concrete-coated cardboard collectors of the "egg-crate filler" pattern, and the first half of the paper deals with the collection of spat by this method. The advantages claimed for this method of rearing spat are as follows: (1) Freedom from attack by starfish. (2) Production of oysters of good shape by elimination of clustering and distortion. (3) Elimination of losses by smothering and overcrowding. (4) Advantageous

exploitation of spat set on cardboard collectors. (5) Ease of transfer from one ground to another.

The most satisfactory artificial collectors were ordinary egg-crate fillers coated with concrete. Directions for coating these fillers are given, together with estimates of cost. Several methods of exposing the collectors for the settlement of spat have been tried, the most satisfactory being the suspension from a float of bundles of coated fillers tied up in wire-netting. The methods of constructing floats etc., and the cost of materials and labour are given in detail. It is recommended that the collectors be exposed a few days after water temperatures of 68° F. or over are experienced. This is the temperature below which spawning is stated not to occur. In Malpeque Bay the settlement of spat averaged about 1000 per collector over a period of years. The spat are removed from the collectors during the late autumn, when the season's growth is complete. During removal the collectors are broken up piecemeal and the spat singled by hand. During the winter the spat is submerged on hard bottoms in shallow crates covered with wire cloth. If ice is avoided the losses are not estimated at more than 5 % during the winter months. During the second summer the spat is reared in floating trays holding seven to ten thousand spat, moored in protected bays. The optimum density of spat is stated to be about 1—1.5 per square inch. The trays are of wood, with a wooden cover, and with bottom and ends covered with galvanised wire cloth. Owing to the prevalence of shipworm all wood has to be primed with white paint and painted before use. A mortality of about 5 % only should experienced during the second summer. After the second summer's growth the young oysters should have reached a diameter of 1—3 inches, and 75 %—80 % can now be planted on firm bottoms without protection. The cost of rearing small oysters by this method is given as 1—1.5 dollars per 1000, while the collection of spat costs approximately 15 cents per 1000. These figures are, however, only provisional and further reduction is possible.

H. A. C.

(Various). "Annual Report Year 1934." Reps. Newfoundland Fish. Res. Lab., Div. of Fish. Res., Dep. Nat. Resources, Newfoundland. Vol. II, No. 3. St. John's, 1935.

Previous reports of this series have been reviewed in this journal, Vols. VIII, p. 274; IX, p. 124; and X, p. 216. The work which Dr. Harold Thompson directs is concerned both with the problems of supply and exploitation of the fisheries and the problems of handling and processing. This unity is rather attractive, all the problems of the industry being considered by one scientific body, but this review is only concerned with the first part of the work in Newfoundland, the fish supply and its capture.

For many years we have known vaguely, from the publications of Beaugé and of Huntsman, that the great cod fisheries of the region were affected by variations in hydrological conditions, which are on a large scale. The workers in Newfoundland are making remarkably fast progress in this enquiry. They express the changes rather simply, as variation in the strength of the cold Arctic Current. They have knowledge, as to the importance of the Arctic contribution, from temperature, salinity, drift bottles, and species in the plankton, which were mentioned in earlier reviews. They now add an interesting series of six species of *Ceratium* and even the eggs or fry of caplin, cod, and dab. The Arctic Current seems to act on cod through temperature, with remarkable effects in detail, both in the

shore and bank fisheries. For example, it affects the potency of the liver oil in vitamin A, because larger fish have more potent oil and larger fish are more affected by warm water than are smaller ones. There is also a depth effect because the deeper water is colder.

We may select from the interesting account of the work on salmon, the theory that the Labrador fishery will stand less fishing than those of southern rivers, because the rate of replenishment is slower, there being 5 years of parr life.

M. G.

(Various). "James Johnstone Memorial Volume." The University Press of Liverpool. Liverpool, 1934.

James Johnstone, late Professor of Oceanography in the University of Liverpool, would have vacated his chair in 1935, had he lived until then. There was a scheme afoot to prepare and issue a "Festschrift" in his honour when he did so. But Johnstone died in 1932, and it was then decided that the contemplated "Festschrift" should become a Memorial Volume. This idea bore fruit, and towards the end of 1934 a James Johnstone Memorial Volume was published.

From many pens in divers lands contributions having a bearing on some aspect of Johnstone's particular scientific interests have come to swell the book. It opens with a short biographical note by Prof. F. J. Cole, a lifelong and intimate friend. For this brief sketch of Johnstone's life, and particularly the history of his early struggles to acquire the necessary training for his life's work, both those who knew and worked with him, and also those of us who belong to a younger generation, will be grateful.

The remainder of the book contains no less than twenty-two papers on subjects so widely separated — a reflection of Johnstone's remarkable versatility — as "Observations on Certain Human Parasites", "The Distribution of Dissolved Oxygen in the Northern Pacific", and "Herring and Water Movements". It is therefore quite impossible, within the scope of a single article, to review in detail all the component contributions. Special mention must be made, however, of a paper by Dr. E. S. Russell on "Johnstone and the Philosophy of Biology". It consists in the main of an appreciative analysis of Johnstone's last book *The Essentials of Biology*, in which are "summed up in compact form his matured reflections upon the nature and evolution of life". As one of the most active and versatile of that small band of scientific workers in England who pay useful attention to the more speculative aspects of modern biology, no one is more fitted than Dr. Russell to review his late colleague's efforts and achievements in that field. Both theoretical biologists, therefore, and that larger company who, like the present reviewer, lack those rare qualities of intellect which induce successful incursions into philosophical realms but nevertheless endeavour not to overlook the wider problems of biological method, will return to Johnstone's "Essentials" with a livelier interest and derive from it an ampler profit after having read Dr. Russell's illuminating commentary upon it.

In short, every worker in those sciences to which Johnstone devoted his talents, whether they knew him personally or not, will welcome this Memorial Volume on their working bookshelves, both as a permanent tribute to a lost colleague and for the intrinsic worth of several of the papers it contains.

G. A. S.

Current Bibliography.

Prepared by the Editor with the assistance of Miss Thursby-Pelham.

NOTE. The scope of the Bibliography is limited in the main to the area covered by the Council's activities, but there are included papers of general interest relating to other areas in the North Temperate and Arctic regions and exceptionally elsewhere. Limnological references are not as a rule given, but papers relating to brackish waters and to salmon and freshwater fish studied by the Council are included.

The classification of entries follows in a general way that adopted in Dr. Allen's Selected Bibliography published in Vol. I, Nos. 1 and 2 of the Journal, and since reprinted (Price, 1 Kr.).

Subscribers and those on the distribution list will receive regularly upon application to the Administrative Secretary copies of the Bibliography printed on one side of the page only, for use in making up card indices.

The Editor will be glad to be advised of emendations and additions to the Bibliography.

Physical and Biological Conditions in the Sea.

GENERAL HYDROGRAPHY

Anon. Observaçoês oceanográficas. "Albacora", 1934. Trav. Stat. Biol. Marit. de Lisbonne, No. 35, 1935.

Anon. Resumen de los trabajos presentados. Seccion de Oceanografía e Hidrología. Rev. del Consejo Oceanogr. Ibéro-Americano, Año VI, 45—60, Madrid, 1935.

Fridriksson, A. Ársrit Fiskifelags Islands 1935. I. Fiskirannsoknir IV. Reykjavik, 1935.

Galbis, J. Rapport sur l'étude géophysique de la Méditerranée (2e rapport). Comm. Internat. p. l'Explor. Sci. de la Mer Méditerranée. Rapp. et Proc.-Verb., N. S. IX, 59—83, Paris, 1935.

Granqvist, G. The Thalassological Summer Cruise in 1935. Merentut. Julk., No. 103, Helsinki, 1935.

International Council. Bulletin Hydrographique pour l'Année 1934. Cons. Perm. Internat. p. l'Explor. de la Mer, Copenhague, 1935.

Jurva, R. Übersicht der Eisverhältnisse im Winter 1933—34 an den Küsten Finnlands. Merentut. Julk., No. 97, Helsinki, 1935. (In Finnish and Swedish, German Résumé).

Liebmann, M. E. Òbservations océanographiques sur les côtes de Palestine. Comm. Internat. p. l'Explor. Sci. de la Mer Méditerranée. Rapp. et Proc.-Verb., N. S. IX, 181—86, Paris, 1935.

Marr, J. W. S. The South Orkney Islands. Discovery Rep., X, 283—382, Cambridge, 1935.

Trolle, A. M/S "Thor"s Havundersøgelsestogt 1934. Publik. om Østgrønland, Nr. 3, København, 1935. (French and English Résumés).
Wimpenny, R. S. Some Hydrographic Data from the Suez Canal 1928—29. Coast-guards and Fish. Serv., Fish. Res. Section, Bull. No. 1, Cairo, 1930.
Zarins, E. und Ozolins, J. Untersuchungen über die Zusammensetzung des Meerwassers im Rigaschen Meerbusen und an der lettländischen Küste des Baltischen Meeres. Journ. du Conseil, X, 275—301, Copenhague, 1935.

Physics and Chemistry of Sea Water.

Bein, W. Physikalische und chemische Konstanten des Meerwassers. Veröff. Inst. f. Meereskunde, N. F., A., Heft 28, 36—64, Berlin, 1935.
De Buen, R. y Navarro, F. de P. Condiciones oceanográficas de la costa catalana entre la frontera francesa y el Golfo de San Jorge. Trab. Inst. Español. de Oceanogr., Núm. 14, Madrid, 1935.
De Buen, R. Caracteres oceanográficos del Estrecho de Gibraltar en 1934 (Campañas del Xauen). Notas y Resúmenes, Ser. II, Núm. 91, Madrid, 1935.
Dietrich, G. Aufbau und Dynamik des südlichen Agulhasstromgebietes. Veröff. Inst. f. Meereskunde, N. F., A., Heft 27, Berlin, 1935.
Hirsekorn, H. G. Methoden und Instrumente zur Meerwasser-Dichtebestimmung. I. Die optischen Methoden und Instrumente. Veröff. Inst. f. Meereskunde, N. F., A., Heft 28, 8—28, Berlin, 1935.
Hirsekorn, H. G. Methoden und Instrumente zur Meerwasser-Dichtebestimmung. II. Die elektrische Leitfähigkeits-Apparatur. Veröff. Inst. f. Meereskunde, N. F., A., Heft 28, 29—32, Berlin, 1935.
Möller, L. Überblick über Methoden direkter und indirekter Dichtebestimmung des Meerwassers. Veröff. Inst. f. Meereskunde, N. F., A., Heft 28, 1—28, Berlin, 1935.
Picotti, M. Rapport sur la Chimie Générale (2e rapport). Comm. Internat. p. l'Explor. Sci. de la Mer Méditerranée. Rapp. et Proc.-Verb., N. S. IX, 31—8, Paris, 1935.
Wattenberg, H. Aufgaben der chemischen Meeresforschung. Zeitschr. f. d. ges. Naturwiss., VI, 1935.

TEMPERATURE AND SALINITY

Beaugé, L. Contribution à l'étude des transgressions au point de vue de leur répercussion sur l'habitat biologique. Pêche Marit., Pêche Fluviale et Piscicult., XIX, 10—11, Paris, 1936.
Granquist, G. Regular Observations of Temperature and Salinity in the Seas around Finland. Merentut. Julk., No. 105, Helsinki, 1935.
Hachey, H. B. The Waters of the Scotian Shelf. Progress Rep. Atlant. Biol. Stat., St. Andrew's, N. B., No. 16, 3—6, 1935.
Lumby, J. R. Salinity and Temperature of the English Channel. Estimation of Mean Values for the Upper Water Layer over the 25-Year Period 1903 to 1927. Min. Agric. and Fish., Fish. Invest. Ser. II, XIV, No. 3, London, 1935.
Möller, L. Zur Charakteristik der Wasserkörper des Atlantischen Ozeans. I. Methode und Verarbeitung. Veröff. Inst. f. Meereskunde, N. F., A., Heft 28, 191—93, Berlin, 1935.
Oellrich, H. Die Eisverhältnisse an den deutschen Küsten usw. im Winter 1934/35. Seewart, Heft 4, Hamburg, 1935.
Oellrich, H. Die Eisverhältnisse des Winters 1934/35 in den ausserdeutschen europäischen Gewässern. Ann. der Hydrogr. usw., LXIII, 439—41, Berlin, 1935.
Phifer, L. D. and Utterback, C. L. Some Meteorological Observations. Journ. du Conseil, X, 315—17, Copenhague, 1935.
Picotti, M. Rafrattometria dell'acqua marina e tavole per la misura dell salinità. R. Com. Talassogr. Ital., Mem. CCXXI, Venezia, 1935.
Navarro, F. de P. Nuevos datos sobre la continua variacíon de la temperatura de las aguas submarinas en la bahía de Palma de Mallorca. Notas y Resúmenes, Ser. II, Núm. 90, Madrid, 1935.
Wüst, G. Fortschreitende Salzgehaltsabnahme im Suezkanal. Ann. der Hydrogr. usw., LXIII, 391—95, Berlin, 1935.

HYDROGEN ION-CONCENTRATION AND DISSOLVED GASES

Ercogovic, A. Recherches sur l'Alcalinité et l'Equilibre de l'Acide carbonique dans les eaux côtières de l'Adriatique oriental moyen. Acta Adriatica, No. 7, Split, 1935.

OTHER CONSTITUENTS

Cooper, L. H. N. Iron in the Sea and in Marine Plankton. Proc. Roy. Soc. London, Ser. B, CXVIII, 419—38, 1935.
Stewart, L. C. Commercial extraction of bromine from sea water. Ann. Rep. Smithsonian Inst. for 1934, 153—68, Washington, D. C., 1935.
Wattenberg, H. Kalkauflösung und Wasserbewegung am Meeresboden. Ann. der Hydrogr. usw., LXIII, 387—91, Berlin, 1935.

Currents.

Anon. Westliche Stromversetzungen im Golfstrom. Seewart, Heft 4, Hamburg, 1935.
Anon. Stromversetzungen bei Kap Guardafui im September. Seewart, Heft 4, Hamburg, 1935.
Anon. General Bathymetric Chart of the Oceans, Third Edition of Sheet A_1. North Atlantic Ocean, and Information concerning the preparation of the Third Edition of Sheet A_1. Spec. Publ. Internat. Hydrogr. Bureau, No. 30, Monaco, 1935.
Carruthers, J. N. A "Vertical Log" Current Meter. Hydrogr. Rev., XII, 62—76, Monaco, 1935.
Clowes, A. J. and Deacon, G. E. R. The Deep-Water Circulation of the Indian Ocean. Nature, CXXXVI, 936—38, London, 1935.
Defant, A. Der äquatoriale Gegenstrom. Sitzungsber. d. Preuss. Akad. d. Wiss., Phys-Math. Klasse, XXVIII, 450—72, Berlin, 1935.
Deutsche Seewarte. Meereskundliche Beobachtungen auf deutschen Feuerschiffen der Nord- und Ostsee, Jahr 1934. Hamburg, 1935.
Dietrich, G. Zur Dynamik des atlantischen Zweiges des Agulhasstromes. Ann. der Hydrogr. usw., LXIII, 383—87, Berlin, 1935.
Dietrich, G. Aufbau und Dynamik des südlichen Agulhasstromgebietes. Veröff. Inst. f. Meereskunde, N. F., A., Heft 27, Berlin, 1935.
Schumacher, A. Über Stromkabbelungen, besonders in Guineastrom und seiner Umgebung. Ann. der Hydrogr. usw., LXIII, 373—82, Berlin, 1935.
Wattenberg, H. Kalkauflösung und Wasserbewegung am Meeresboden. Ann der Hydrogr. usw., LXIII, 387—91, Berlin, 1935.

Tides.

Anon. Manual of Tide Observations. U. S. Coast and Geodetic Survey, Special Publ. No. 196, Washington, D. C., 1935.
Anon. Tide-Gauge Observations in France. Hydrogr. Rev., XII, 110—12, Monaco, 1935.
Marguet, F. Notes sur les marées. Marées stationnaires du large et marées progressives littorales. Ann. de Géogr., No. 247, Paris, 1935.
Marmer, H. A. The variety in tides. Ann. Rep. Smithsonian Inst. for 1934, 181—92, Washington, D. C., 1935.
Nomitsu, T. and Habu, K. Proper Oscillations of the Sea of Continental Shelf. Mem Coll. Sci., Kyoto Imp. Univ., Ser. A, XVIII, 247—53, Kyoto, 1935.
Stenij, S. E. Vedenkorkeusarvoja 1934. Merentut. Julk., No. 104, Helsinki, 1935. (German Résumé).

LIGHT, COLOUR AND TRANSPARENCY

Burr, G. O. and Burr, M. M. A rapid survey instrument for the measurement of light intensity under water. Ecology, XV, 326—28, New York, 1934.
Pettersson, H. Transparency of Sea Water. Nature, CXXXVII, 68, London, 1936.

Oceanography-Miscellaneous.

Galbis, J. Rapport sur l'étude géophysique de la Méditerranée (2e rapport). Comm. Internat. p. l'Explor. Sci. de la Mer Méditerranée. Rapp. et Proc.-Verb., N. S. IX, 59—83, Paris, 1935.
Loewe, F. The Exploration of the Greenland Ice-Cap, 1929—1934. Scottish Geogr. Mag., LI, 347—53, Edinburgh, 1935.
Namekawa, T. A Study of the Minor Fluctuation of the Atmospheric Pressure (IV) Part III. Seiches of Lakes or Bats due to Microbaric Disturbances. Mem. Coll. Sci. Kyoto Imp. Univ., Ser. A, XVIII, 317—28, Kyoto, 1935.
Richard, J. et Sirvent, L. Liste des opérations faites dans les parages de Monaco à bord de *l'Eider* et du *Sténo* pendant l'année 1912. Bull. Inst. Océanogr., No. 684, Monaco, 1935.

Stocks, T. Research into the Nature and Stratification of the Sea Bottom by means of high frequency "Echolots". Hydrogr. Rev., XII, 101—05, Monaco, 1935.
Vallaux, C. Géographie générale des mers. Paris, 1933.

Plankton.

Allen, W. E. "Yellow Water" in La Jolla Bay in 1935. Science, N. S. LXXXII, 325—26, New York, 1935.
Blum, H. F. L'orientation du copepode *Harpacticus fulvus* sous l'influence de la lumière. Arch. Internat. Physiol., XXXVIII, 1—8, Liège et Paris, 1934.
Broch, H. Craspedote Medusen. Teil II. Trachy- und Narcomedusen. Nordisches Plankton, Lief. XXI, XII, Kiel und Leipzig, 1929.
Burckhardt, A. Die Ernährungsgrundlagen der Copepodenschwärme der Niederelbe. Internat. Rev. d. ges. Hydrobiol. usw., XXXII, 432—500, Leipzig, 1935.
Le Calvez, J. Flagellispores du Radiolaire *Coelodendrum ramossissinum* (Haeckel). Arch. Zool. Expér. et Gén., LXXVII, Notes et Revue, 99—103, Paris, 1935.
Chevreux, E. Amphipodes provenant des Campagnes scientifiques du Prince Albert Ier de Monaco. Résult. Camp. Sci., Fasc. XC, Monaco, 1935.
Clarke, G. L. Factors affecting the vertical distribution of copepods. Ecolog. Monogr., IV, 530—540, Durham, N. C., 1934.
Cooper, L. H. N. Iron in the Sea and in Marine Plankton. Proc. Roy. Soc. London, Ser. B, CXVIII, 419—38, 1935.
Fridriksson, A. Ársrit Fiskifélags Islands 1935. I. Fiskirannsoknir IV. Reykjavik, 1935.
Früchtl, F. Beitrag zur Kenntnis der Missbildungen adriatischer Planktoncopepoden. Sitzungsber. Akad. Wiss. Wien, Math.-Nat. Klasse, CXLIII, 1934.
Garstang, W. and Georgeson, E. Report on the Tunicata. Part II, — Copelata. Brit. Antarctic ("Terra Nova") Exped. 1910, Nat. Hist. Rep. Zoology, IV, No. 8, 263—82, Brit. Mus. (Nat. Hist.), London, 1935.
Gran, H. H. and Braarud, T. A quantitative study of the phyto-plankton in the Bay of Fundy and the Gulf of Maine (including observations of hydrography, chemistry and turbidity). Journ. Biol. Board Canada, I, 279—467, Toronto, 1935.
Hardy, A. C. and Gunther, E. R. The Plankton of the South Georgia Whaling Grounds and adjacent Waters, 1926—1927. Discovery Rep., XI, 1—456, Cambridge, 1935.
Issel, R. Rapport sur le Plancton (7e rapport). Comm. Internat. p. l'Explor. Sci. de la Mer Méditerranée. Rapp. et Proc.-Verb., N. S. IX, 85—94, Paris, 1935.
Johnson, M. W. The developmental stages of *Labidocera*. Biol. Bull., Woods Hole, Mass., LXVIII, 397—421, U. S. A., 1935.
Kiefer, F. Zur Kenntnis der *Oithonidae* (Crustacea Copepoda Cyclopoida). Zool. Anz., CXII, 322—27, Leipzig, 1935.
Klie, W. Die Fischereigründe vor Alexandrien. V. Ostracoda. Fish. Res. Directorate, Notes and Mem., No. 12, Cairo, 1935.
Komai, T. On *Stephanoscyphus* and *Nausithoë*. Mem. Coll. Sci., Kyoto Imp. Univ., Ser. B, X, 289—339, Kyoto, 1935.
Komai, T. On the Structure of *Ctenoplana*. Mem. Coll. Sci., Kyoto Imp. Univ., Ser. B, X, 245—56, Kyoto, 1935.
Kramp, P. L. Craspedote Medusen. Teil III. Leptomedusen. Nordisches Plankton, Lief. XXII, XII, Kiel und Leipzig, 1933.
Lang, K. Beiträge zur Kenntnis der Harpacticiden. Zool. Anz., CXII, 332—36, Leipzig, 1935.
Leavitt, B. B. A quantitative study of the vertical distribution of the larger zooplankton in deep water. Biol. Bull., Woods Hole, Mass., LXVIII, 115—30, U. S. A., 1935.
Leloup, E. Contribution à la Répartition de *Tetraplatia volitans* (Busch). Bull. Mus. Roy. d'Hist. Nat. de Belgique, XI, No. 4, Bruxelles, 1935.
Liebmann, M. E. Observations océanographiques sur les côtes de Palestine. Comm. Internat. p. l'Explor. Sci. de la Mer Méditerranée. Rapp. et Proc.-Verb., N. S. IX, 181—86, Paris, 1935.
Lowndes, A. G. The Swimming and Feeding of Certain Calanoid Copepods. Proc. Zool. Soc. London, Part III, 687—715, 1935.
Mackintosh, N. A. and Rayner, G. W. Recent Antarctic Research undertaken by the Discovery Committee. Nature, CXXXVI, 629—31, London, 1935.
Mielck, W. und Künne, C. Fischbrut- und Plankton-Untersuchungen auf dem Reichsforschungsdampfer "Poseidon" in der Ostsee, Mai—Juni 1931. Wiss. Meeresunters., N. F., Abt. Helgoland, XIX, Abhandl. Nr. 7, Kiel und Leipzig, 1935.

Nielsen, E. S. Eine Methode zur exakten quantitativen Bestimmung von Zooplankton. Mit allgemeinen Bemerkungen über quantitative Planktonarbeiten. Journ. du Conseil, X, 302—14, Copenhague, 1935.
Okada, Y. K. Les jeunes Physalies. Note supplémentaire sur le développement postembryonnaire de la Physalie. Mem. Coll. Sci., Kyoto Imp. Univ., Ser. B, X, 407—10, Kyoto, 1935.
Ranson, G. Contribution à l'interprétation objective des formes et de leur rapports dans la classe Hydrozoa. Bull. Mus. Nation. d'Hist. Nat., 2e Série, VII, 247—53, Paris, 1935.
Reisinger, E. Turbellaria. Nordisches Plankton, Lief. XXII, X, Kiel und Leipzig, 1933.
Russell, F. S. and Colman, J. S. The Zooplankton. IV. The occurrence and seasonal distribution of the Tunicata, Mollusca and Coelenterata (Siphonophora). Great Barrier Reef Exped. 1928—29, Sci. Rep. II, No. 7, 203—76, Brit. Mus. (Nat. Hist.), London, 1935.
Schröder, O. Spumellarien. Teil I. Sphaerocollida. Nordisches Plankton, Lief. XXI, XVI, Kiel und Leipzig, 1929.
Steuer, A. The Fishery Grounds near Alexandria. I — Preliminary Report. Fish. Res. Directorate, Notes and Mem., No. 8, Cairo, 1935.
Wilson, D. P. Life of the Shore and Shallow Sea. London, 1935.
Zo Bell, C. E. The Assimilation of Ammonium Nitrogen by *Nitzschia closterium* and other Marine Phytoplankton. Proc. Nat. Acad. Sci., XXI, 517—22, Washington, 1935.

CONDITIONS OF PRODUCTION IN THE SEA

Schnakenbeck, W. Die biologischen Grundlagen für die Fischerei in der Niederelbe. 6. Die Wirkungen der aussergewöhnlichen Wasserverhältnisse 1933 bis 1935. Der Fischmarkt, N. F. III, Heft 12, 323—27, Cuxhaven, 1935.
Wilson, D. P. Life of the Shore and Shallow Sea. London, 1935.

Marine Plants.

Blegvad, H. An Epidemic Disease of the Eel-Grass *(Zostera marina* L.). Rep. Danish Biol. Stat., XXXIX, 1—8, Copenhagen, 1935.
Leib, E. Beiträge zur Physiologie und Pathologie der *Cladophora-Zelle.* Wiss. Meeresunters., N. F., Abt. Helgoland, XIX, Abhandl. No. 7, Kiel und Leipzig, 1935.
Lucas, A. H. S. The Marine Algae of Lord Howe Island. Proc. Linnean Soc. N. S. Wales, LX, 194—232, Sydney, 1935.
Petersen, H. E. Preliminary Report on the Disease of the Eel-Grass *(Zostera marina* L.). Rep. Danish Biol. Stat., XL, 3—8, Copenhagen, 1935.
Politis, J. Rapport sur les Algues Marines (2e rapport). Comm. Internat. p. l'Explor. Sci. de la Mer Méditerranée. Rapp. et Proc.-Verb., N. S. IX, 131—36, Paris, 1935.

Bottom Deposits.

von Bülow, B. Fr. Arsengehalt ozeanischer Bodenproben der atlantischen "Meteor" Expedition. Ann. der Hydrogr. usw., LXIII, 395—97, Berlin, 1935.
Kurbatov, L. M., Radioactivity of Ferro-Manganese Formations in Seas and Lakes of the U. S. S. R. Nature, CXXXVI, 871, London, 1935.
Niino, H. On the Soundings from the Banks between the Oga Peninsula and Sado Island, in the North Eastern Part of the Japan Sea. Journ. Imp. Fish. Inst., XXXI, 11—33, Tokyo, 1935.

Bottom Fauna.

GENERAL

Allee, W. C. Concerning the organization of marine coastal communities. Ecolog. Monogr. IV, 541—54, Durham, N. C., 1934.
Beatson, J. B., Nicol, E. A. T. and Elton, C. Notes on some Interesting Animals stranded on the West Coast of Scotland during the Summer of 1935. Scottish Naturalist, No. 217, 27—30, Edinburgh, 1936.
Edmundsen, C. H. Reef and Shore Fauna of Hawaii. Bernice P. Bishop Mus. Spec. Publ., XXII, 1—295, 1933.

Fraser, J. H. An Experiment on the powers of survival of animals and plants from a pool above high-water mark. Journ. Anim. Ecol., IV, 229—30, Cambridge, 1935.
Giacomo, C. Primo elenco di animali marini in vendita presso l'Instituto Centrale di Biologia marina in Messina. R. Com. Talassogr. Ital., Mem. CCXXII, Venezia, 1935.
Kitching, J. A. An introduction to the Ecology of Intertidal Rock Surfaces on the Coast of Argyll. Trans. Roy. Soc. Edinburgh, LVIII, 351—74, 1935.
Redeke, H. C. Essay Review. Some Recent Publications on the Fauna of Brackish Waters in the Netherlands. Journ. du Conseil, X, 319—23, Copenhague, 1935.
Steuer, A. The Fishery Grounds near Alexandria. I. Preliminary Report. Fish. Res. Directorate, Notes and Mem., No. 8, Cairo, 1935.
Vatova, A. The Fishery Grounds near Alexandria. II. A Bottom Sample taken at Alexandria. Fish. Res. Directorate, Notes and Mem., No. 9, Cairo, 1935.
Weill, R. Revue des Protistes commensaux ou parasites des Cnidaires. Arch. Zool. Expér. et Gén., LXXVII, Notes et Revue, 47—70, Paris, 1935.
Wilson, D. P. Life of the Shore and Shallow Sea. London, 1935.

PHYSIOLOGY AND BEHAVIOUR

Courtois, D. La régulation de la composition minérale de l'hémolymphe des crustacés. Ann. Physiol. et de Physicochim. Biol., X, 377—414, 1934.
Edmonds, E. The Relations between the Internal Fluid of Marine Invertebrates and the Water of the Environment, with special reference to Australian Crustacea. Proc. Linnean Soc. N. S. Wales, LX, 233—47, Sydney, 1935.
Fox, D. L. Concerning Enzymic Reactions in Heavy Water. Journ. Cell. and Comp. Physiol., VI, 405—24, Philadelphia, 1935.
Galtsoff, P. S. The biochemistry of the invertebrates of the Sea. Ecolog. Monogr., IV, 481—90, Durham, N. C., 1934.
Mutscheller, F. Experimentelle Untersuchung der Organe der Weibchen von *Bonellia viridis*, deren Extrakte vermännlichend wirken, auf das Vorkommen von Schwermetallen, insbesondere von Kupfer. Biol. Zentralbl., LV, 615—25, Leipzig, 1935.
Myers, E. H. Culture Methods for the Marine Foraminifera of the Littoral Zone. Trans. Amer. Microsc. Soc., LIV, 264—67, Lancaster, Pa., 1935.
Okada, Y. K. und Miyashita, Y. Über die vollständige Geschlechtsumkehr bei den mit *Sacculina* infizierten Männchen der japanischen Wollhandkrabbe, *Eriocheir japonicus* de Haan. Biol. Zentralbl., LV, 625—34, Leipzig, 1935.
Orton, J. H. Experimental Regeneration in the Sea of the Hind Body in *Arenicola marina* Linn. Ann. and Mag. Nat. Hist., 10th Ser., XVI, 641—43, London, 1935.
Orton, J. H. and Smith, C. L. Experiments with *Amphitrite* and its Commensals. Ann. and Mag. Nat. Hist., 10th Ser., XVI, 644—45, London, 1935.
Pantin, C. F. A. On the Excitation of Crustacean Muscle: II. Neuromuscular Facilitation. Journ. Exper. Biol., XIII, 111—30, Cambridge, 1936.
Raffy, A. Influence des variations de salinité sur l'intensité respiratoire de la Telphuse et de l'Écrivisse. C. R. Acad. Sci., CXCVIII, 680—81, Paris, 1934.
Tsujimoto, M. and Koyanagi, H. On the fatty substances of shellfish. Journ. Soc. Chem. Indust., Suppl. Bind., XXXVII, 81 B—86 B, Tokyo, 1934.
Wiersma, C. A. G. und Harreveld, A. van. On the nerve-muscle system of the hermit crab *(Eupagurus bernhardus)*. I. The contraction of the abductor and the adductor of the claw. Arch. Néerland. Physiol., XIX, 426—444, 's Gravenhage, 1934.
Young, J. Z. The Giant Nerve Fibres and Epistellar Body of Cephalopods. Quart. Journ. Microscop. Sci., LXXVIII, 367—86, London, 1936.

SPECIAL GROUPS

Barnes, T. C. Salt Requirements and Orientation of *Ligia* in Bermuda, III. Biol. Bull., Woods Hole, Mass., LXIX, 259—68, U. S. A., 1935.
Berkeley, E. Swarming of *Odontosyllis phosphorea*, Moore, and of other Polychaeta near Nanaimo, B. C. Nature, CXXXVI, 1029, London, 1935.
Breitfuss, L. Le Spugne calcaree dell'Adriatico con riflesso a tutto il Mediterraneo. R. Com. Talassogr. Ital., Mem. CCXXIII, Venezia, 1935.
Broch, H. The Fishery Grounds near Alexandria. III. Cirripeds. Fish. Res. Directorate, Notes and Mem., No. 10, Cairo, 1935.
Burton, M. Notes on Sponges from South Africa, with Descriptions of New Species. Ann. and Mag. Nat. Hist., 10th Ser., XVII, 141—47, London, 1936.

Le Calvez, J. Sur quelques Foraminifères de Villefranche et de Banyuls. Arch. Zool. Expér. et Gén., LXXVII, Notes et Revue, 79—98, Paris, 1935.
Chevreux, E. Amphipodes provenant des Campagnes scientifiques du Prince Albert Ier de Monaco. Résult. Camp. Sci., Fasc. XC, Monaco, 1935.
Chrenko, F. A. A list of parasitic Rhabdocoela (Turbellaria) of Plymouth. Parasitology, XXVI, 114—16, Cambridge, 1934.
Crawford, G. I. *Corophium curvispinum*, G. O. Sars. var. *devium*, Wundsch, in England. Nature, CXXXVI, 685—86, London, 1935.
Dautzenberg, P. Gastéropodes Marins. 1. Famille Terebridae. 2. Famille Mitridae. Résult. Sci du Voyage aux Indes Orient., Néerland., II, Fasc. 17, Bruxelles, 1935.
Derjugin, K. M. and Kobjakowa, S. Zur Decapoden Fauna des Japanischen Meeres. Zool. Anz., CXII, 141—47, Leipzig, 1935.
Entz, G. Über schnelles Wachstum und rasche Entwicklung eines Phycomyceten-protisten *Oovorus copepodorum* (n. gen. n. sp.). Arch. f. Protistenk., LXIX Bd., Heft 2, 175—94, Jena, 1930.
Fauvel, P. Sur quelques Syllidiens du Japon. Annot. Zool. Japon., XIV, 301—15, Tokyo, 1934.
Gallo, V. R. Adición a las notas sobre "algunos equinodermos de Groenlandia". Notas y Resúmenes, Ser. II, Núm. 87, Madrid, 1935.
Gordon, I. Anomura (Excluding Paguridea). Résult. Sci. du Voyage aux Indes Orient. Néerland., III, Fasc. 17, Bruxelles, 1935.
Gordon, I. On New or Imperfectly Known Species of Crustacea Macrura. Journ. Linn. Soc. Zool., XXXIX, 339—51, London, 1935.
Guiart, J. Cestodes parasites provenant des Campagnes scientifiques du Prince Albert Ier de Monaco. Résult. Camp. Sci., Fasc. XCI, Monaco, 1935.
Ivanic, M. Über die bei den Palmellastadien von *Euglena viridis* Ehrbg. vorkommende "Häutung" und deren Bedeutung. Zool. Anz., CXIII, 62—4, Leipzig, 1936.
Kobjakova, S. Beschreibung neuer Dekapoden-Formen aus dem Japanischen Meer. Zool. Anz., CXII, 85—92, Leipzig, 1935.
Labbé, A. Les yeux dorsaux des Silocordermés (Note préliminaire). Arch. Zool. Expér. et Gén., LXXVII, Notes et Revue, 16—35, Paris, 1935.
Leigh-Sharpe, W. H. A third list of parasitic Copepoda of Plymouth with notes. Parasitology, XXVI, 112—13, Cambridge, 1934.
Leloup, E. *Halammohydra* et les Siphonophores Chondrophorides. Bull. Mus. Roy. d'Hist. Nat. de Belgique, XI, No. 23, Bruxelles, 1935.
Lin, S. Y. The Development of the Cuttlefish *Sepiella japonica* Sasaki. Bull. Chekiang Prov. Exper. Stat. Tinghai, I, No. 5, Chekiang, China, 1935.
Linke, O. Der Laich von *Littorina (Meleraphe) neritoides* L. Zool. Anz., CXII, 57—62, Leipzig, 1935.
Monro, C. C. A. Polychaete Worms. II. Discovery Rep., XII, 59—198, Cambridge, 1936.
Neu, W. *Balanus eburneus* Gould und *Balanus improvisus* Darwin als Bewuchs ausgehängter Platten im Goldenen Horn von Istanbul. Zool. Anz., CXII, 92—5, Leipzig, 1935.
Newcombe, C. L., Miller, C. E. and Chappell, D. W. Preliminary Report on Respiratory Studies of *Littorina irrorata*. Nature, CXXXVII, London. 1936.
Nouvel, H. et L. Observations sur la biologie d'une Crevette *Athanas nitescens* Leach. Bull. l'Inst. Océanogr., No. 685, Monaco, 1935.
Okada, Y. K. *Amblyosyllis nigrolineata*, une nouvelle variété de *l'A. speciosa* Izuka. Annot. Zool. Japon., XIV, 317—20, Tokyo, 1934.
Panning, A. Die Gattung Holothuria (2., 3. und 4. Teil). Mitt. aus dem Zool. Staatsinst. und Zool. Museum in Hamburg, XLV, 24—50, 63—107, Hamburg, 1935.
Pyefinch, K. A. Habitat of *Procerodes* (Gunda) *ulvae*. Nature, CXXXVII, 32, London, 1936.
Ranson, G. Contribution à l'interprétation objective des formes et de leurs rapports dans la classe Hydrozoa. Bull. Mus. Nation. d'Hist. Nat., 2e Série, VII, 247—53, Paris, 1935.
Rees, W. J. The Anatomy of *Cercaria buccini* Lebour, 1911. Proc. Zool. Soc. London, 1935, Part II, 309—12, 1935.
Rioja, E. Anélidos Poliquetos procendentes de la campañas del Instituto Español de Oceanografía. Trab. Inst. Español de Oceanogr., Núm. 13, Madrid, 1935.
Russell, H. D. Some Nudibranchs of Bermuda, with a description of a New Species. Nautilus, XLIX, 59—61, Philadelphia and Boston, 1935.
Sakai, T. Species of the Genus *Pinnixa* (Pinnotherid Crab) found in the Far East. Sci. Rep. Tokyo Bunrika Daigaku, Section B, II, 37—43, Tokyo, 1934.

Sakai, T. New or rare Species of Brachyura, collected by the "Misago" during the Zoological Survey around the Izu-Peninsula. Sci. Rep. Tokyo Bunrika Daigaku, Section B, II, 63—88, Tokyo, 1935.
Sanzo, L. Uova, Sviluppo embrionale, Stadi larvali, post-larvali e giovanili di Sternoptychidae e Stomiatidae. Sternoptychidae 3. *Maurolicus pennanti* (Walb.). R. Com. Talassogr. Ital., Mem. CCXXI, Venezia, 1935.
Schurin, A. Zur Fauna der Caprelliden der Bucht Peters des Grossen (Japanischen Meer). Zool. Anz., CXII, 198—203, Leipzig, 1935.
Serventy, D. L. Observations on *Gammarus zaddachi* Sexton, an estuarine Amphipod, and Associated Forms. Internat. Rev. d. ges. Hydrobiol. usw., XXXII, 285—94, Leipzig, 1935.
Shiino, S. M. Bopyrids from Tanabe Bay. II. Mem. Coll. Sci. Kyoto Imp. Univ., Ser. B, IX, 257—87. Kyoto, 1934.
Spärck, R. On the occurrence of *Crepidula fornicata* (L) in the Limfjord. Rep. Danish Biol. Stat., XC, 43—4, Copenhagen, 1935.
Stekhoven, J. H. S. Additional Notes to my Monographs on the Freeliving Marine Nemas of the Belgian Coast. I and II. Mém. Mus. Roy d'Hist. Nat. de Belgique, No. 72, Bruxelles, 1935.
Webb, D. A. The Histology, Cytology and Embryology of Sponges. Quart. Journ. Microsc. Sci., LXXVIII, 51—70, London, 1935.
Viets, K. The Fishery Grounds near Alexandria. IV. Some Marine Mites from Alexandria. Fish. Res. Directorate, Notes and Mem., No. 11, Cairo, 1935.
Wheeler, J. F. G. Record of *Gorgonorhynchus* at Bermuda. Nature, CXXXVII, 33, London, 1936.

Fishery Investigations.

GENERAL

Anon. Resumén de los trabajos presentados. Seccíon de Biologia y Pesca. Rev. del Consejo Oceanogr. Ibero-Americano, Año VI, 63—76, Madrid, 1935.
Von Bonde, C. Report No. 12 for the year ending December 1934, with Annex A, Résumé of Operations of the R. S. "Africana"; Annex B, List of Stations of the R. S. "Africana". Fish. and Mar. Biol. Survey, Union of S. Africa, Rep. No. 12 for the year ending December 1934, 6—110, Pretoria, 1934.
Dakin, W. J. Some recent researches in Marine Zoology and their bearing upon Current Problems of to-day. Rep. Melbourne (1935) Meeting Australian and New Zealand Assoc. for the Advancement of Sci., 147—64, 1935.
Fischer, E. Die wichtigste Fischereiliteratur aus dem Jahre 1934. A. Seefischerei. Jahresber. Deutsch. Fisch. 1934, 284—90, Berlin, 1935.
Graham, M. Modern Theory of Exploiting a Fishery, and Application to North Sea Trawling. Journ du Conseil, X, 264—74, Copenhague, 1935.
Heinrici, C. Die Arbeiten der Deutschen wissenschaftlichen Kommission für Meeresforschung. Jahresber. Deutsch. Fisch. 1934, 190—206, Berlin, 1935.
Hjort, J. Human activities and the study of Life in the sea; an essay on methods of research and experiment. Geogr. Rev., New York, 1935.
Scotland. Scottish Marine Biological Association. Annual Report 1934—35. Glasgow.

COMMERCIAL FISHERIES

Ahlf, R. Die deutsche Hochseefischerei im Jahre 1934. Jahresber. Deutsch. Fisch. 1934, 207—23, Berlin, 1935.
Anderson, A. W. and Pottinger, S. R. Quality of non-oily Fish Meals. U. S. Bureau of Fish., Invest. Rep., II, No. 30, Washington, D. C., 1935.
Anderson, A. W., Harrion, R. W. and Pottinger, S. R. Studies on Drying Cod and Haddock Waste. U. S. Bureau of Fish., Invest., Rep., II, No. 32, Washington, D. C., 1935.
Bedford, R. H. The Care of Fresh Halibut Aboard Ship. Bull. Biol. Board of Canada, XLIX, Ottawa, 1935.
Boury, M. Rapport sur la Chimie Marine Industrielle (2e rapport). Comm. Internat. p. l'Explor. Sci. de la Mer Méditerranée. Rapp. et Proc.-Verb., N. S. IX, 39—57, Paris, 1935.
British Columbia. Fisheries Commissioner's Report for 1934. Prov. of Brit. Columbia, Rep. Comm. Fish. for the Year ended December 31st, 1934, 5—19, Victoria, B. C., 1935.

Bureau of Commercial Fisheries. The Commercial Fish Catch of California for the Years 1930—34, inclusive. Fish. Bull. No. 44, Div. of Fish and Game of California, Sacramento, 1935.
Cartier, N. La situation des pêcheurs en Bretagne. Pêche Marit., Pêche Fluviale et Piscicult., XIX, 7—9, Paris, 1936.
Denmark. Fiskeri-Beretning for Aaret 1934. København, 1935.
Eichelbaum, E. Die Seefischerei. Jahresber. Deutsch. Fisch. 1934, 5—156, Berlin, 1935.
England. Report on Sea Fisheries for the Year 1934. Min. Agric. and Fish., London, 1935.
Fick, H. Die technische Entwicklung der unterelbischen "Kleinen Hochseefischerei". Der Fischmarkt, N. F. III, Heft 11, 288—95, Cuxhaven, 1935.
Fiedler, R. H. Fishery Industries of the United States, 1934. App. II to Rep. U. S. Comm. of Fish. for 1935, 75—330, Washington, D. C., 1935.
Finzel, W. Die deutsche Fischwirtschaft im Reichsnährstand. Jahresber. Deutsch. Fisch. 1934, 178—89, Berlin, 1935.
Fischer, E. Die Küstenfischerei in der Nord- und Ostsee und die Kutterhochseefischerei. Jahresber. Deutsch. Fisch. 1934, 229—37, Berlin, 1935.
Ireland. Statistical Tables of the Sea and Inland Fisheries together with Abstract of Current By-Laws, Orders, etc. for the Years 1931, 1932 and 1933. Dept. of Agric. Fish. Branch, Dublin, 1935.
Matthews, L. H. The Sea Fish and Fisheries of the Bristol District. Proc. Bristol Nat. Soc., VII, 442—62, Arbroath, 1934.
Miezis, V. Bulletin Statistique des Pêches maritimes de Lettonie, Année 1933. Publ. Fish. Lab., Riga, 1935.
New Zealand. Report on Fisheries for the Year ended 31st March, 1935. Marine Dept. Wellington, 1935.
Norway. Norges Fiskerier, 1933. Norges Offis. Statist., IX, 68, Oslo, 1935.
Norway. Beretninger om torskefisket (utenom Lofoten) og silde-, makrell-, bank- og kveitefisket samt selfangsten i 1934. Årsber. vedk. Norges Fiskerier, 1934, Nr. IV, Bergen, 1935.
Pottinger, S. R., Harrison, R. W. and Anderson, A. W. Effect of Method of Manufacture on the Composition of Haddock Fish-Meal Proteins. U. S. Bureau of Fish., Invest. Rep. No. 31, Washington, 1935.
Smith, W. C. Report on the Manx Sea-Fisheries during the period 1928—1934. Douglas, Isle of Man, 1935.
Sweden. Årsbok 1935. Göteborgs och Bohus Läns Havsfiskeförening, Göteborg, 1935.
Thompson, D'A. W. Bulletin Statistique des Pêches Maritimes des Pays du Nord et de l'Ouest de l'Europe. Vol. XXIII pour l'année 1933. Cons. Perm. Internat. p. l'Explor. de la Mer, Copenhague, 1935.

FISHING GEAR

Von Bonde, C. Report on Preliminary Fishing Experiments with the Trammelnet. Fish. and Mar. Biol. Survey, Union of S. Africa, Annexe C to Report No. 12 for the year ending Dec. 1934, 111—20, Pretoria, 1934.
Fick, H. Über die technische Entwicklung der Fischdampfer. Der Fischmarkt, N. F. IV, 9—13, Cuxhaven, 1936.
Johnson, C. H. Trawler Construction and New Patent Trawl Net. Fishing News, 22—3, Aberdeen, 4—XII—35.
Matthews, L. H. Sea Fish and Fisheries of the Bristol District. Ann. Rep. and Proc. Bristol Nat. Soc., 4th Ser., VII, 424—33, Arbroath, 1934.

Fish.

GENERAL

De Buen, F. Fauna Ictiológica. Catálogo de los peces ibéricos: de la planicie continental, aguas dulces, pelágicos y de los abismos próximos. Primera Parte. Prim. Conferencia Oceanogr. Ibero-Amer. (Madrid—Malaga, Abril 1935), Trab. Present. Num. 1, Madrid, 1935.
De Buen, F. Fauna Ictiológica. Catálogo de los peces ibéricos: de la planicie continental, aguas dulces, pelágicos y de los abismos próximos. Notas y Resúmenes, Ser. II, Núm. 88 & 89, Madrid, 1935.
Desbrosses, P. Présence inusitée de Balistes *Balistes capriscus* (Linné Ed. Gmelin) sur les côtes du Morbihan en 1931 et sur les côtes de France en 1930 et 1931. Bull. Soc. Zool. de France, LIX, 236—41, Paris, 1934.

Desbrosses, P. Échouage d'un Tétrodon *Tetrodon lagocephalus* L. près de Quiberron et Remarques sur la Présence de cette Espèce et de *Balistes capriscus* L. au nord du 44°L. N. Bull. Soc. Zool. de France, LX, 43—8, Paris, 1935.
Giacomo, C. Primo elenco di animali marini in vendita presso l'Instituto Centrale di Biologia marina in Messina. R. Com. Talassogr. Ital., Mem. CCXXII, Venezia, 1935.
Matsubara, K. Studies on the Scorpaenoid Fishes of Japan. II. Statistical Observations on *Sebastodes inermis* (C. et V.). Bull. Japan. Soc. Sci. Fish., IV, 217—23, Tokyo, 1935.
Norman, J. R. Notes on the Fishes of the Family *Scorpaenidae* recorded from the British Coasts, with a description of a new species. Proc. Zool. Soc. London, 1935, 611—14, Part II, 1935.
Norman, J. R. Coast Fishes. Part. I. The South Atlantic. Discovery Rep., XII, 1—58, Cambridge, 1935.
Taranetz, A. J. und Adriashev, A. P. Vier neue Fischarten der Gattung *Lycodes* Reinh. aus dem Ochotskischen Meer. Zool. Anz., CXII, 242—53, Leipzig, 1935.
Vladykov, V. D. et Tremblay, J. L. Liste des poissons recueillis pendant l'été 1934 par la Station biologique du St. Laurent, dans la région de Trois-Pistoles, P. Q. Le Naturaliste Canadien, LXII, 77—82, Québec, 1935.
Wilson, D. P. Life of the Shore and Shallow Sea. London, 1935.

PHYSIOLOGY AND BEHAVIOUR

Allee, W. C., Bowen, E. S., Welty, J. C. and Oesting, R. The effect of homotypic conditioning of water on the growth of fishes, and chemical studies of the factors involved. Journ. Exper. Zool., LXVIII, 183—213, Philadelphia, 1934.
Borodin, N. A. The anabiosis or phenomenon of resuscitation of fishes after being frozen. Zool. Jahrb. (Allg. Zool.), CIII, 313—42, Jena, 1934.
Flower, S. S. Further Notes on the Duration of Life in Animals. I. Fishes; as determined by Otolith and Scale-readings and direct Observations on Living Individuals. Proc. Zool. Soc. London, 1935, Part II, 265—304, 1935.
Fontaine, M. Le calcium sanguin chez les cyclostomes et les poissons et ses rapports avec l'état d'ossification du squelette. Arch. Internat. Physiol., XL, 374—84, Liège et Paris, 1935.
Gimenez, J. C. El valor alimenticio del pescado. Rev. del Cons. Oceanogr. Ibero-Americano, Año IV, 61—90, Madrid, 1933.
Grove, A. J. and Newell, G. E. A Mechanical Investigation into the Effectual Action of the Caudal Fin of some Aquatic Chordates. Ann. Mag. Nat. Hist., 10th Ser., XVII, 280—90, London, 1936.
Haywood, C., Stevens, T. O., Tewinkel, H. M. and Schott, M. The Relative Effects of Increased Carbon Dioxide Tensions and Decreased Oxygen Tensions upon the Heart Frequency of Young Trout. Journ. Cell. and Comp. Physiol., V, 509, Philadelphia, 1935.
Hill, A. V., Parkinson, J. L. and Solandt, W. Y. Photo-electric Records of the Colour Change in *Fundulus heteroclitus*. Journ. Exper. Biol., XII, 397—99, London, 1935.
Hoagland, H. Electrical responses from the lateral-line nerves of fishes. V. Responses in the central nervous system. Journ. Gen. Physiol., XVIII, 89—91, Baltimore, 1934.
Ibáñez, O. G. Nota sobre la determinación de las proteínas del suero sanguineo y variaciones de la razón (serina: globulina) en el de algunos peces, por cambios de salinidad. Notas y Resúmenes, Ser. II, Núm. 92, Madrid, 1935.
Neu, W. Hydromechanische Untersuchungen an Fischen zur Lösung des Form-problems. Internat. Rev. d. ges. Hydrobiol. usw., XXXII, 295—315, Leipzig, 1935.
Neu, W. Beitrag zur Bewegungsphysiologie der Lippfische (Labridae). Acta Adriatica, No. 6, Split, 1935.
Nikoljukin, N. I. Über Kreuzungsversuche an Knochenfischen. Zool. Anz., CXII, 305—18, Leipzig, 1935.
Okada, Y. Preliminary Note on the Pearl Organs in some Japanese cyprinoid Fishes. Sci. Rep. Bunrika Daigaku, Section B, II, 29—36, Tokyo, 1934.
Richardson, E. G. The Physical Aspects of Fish Locomotion. Journ. Exper. Biol., XIII, 63—74, Cambridge, 1936.
Smith, H. W. The retention and physiological role of urea in the Elasmobranchii. Biol. Rev. Cambridge Phil. Soc., XI, 49—82, Cambridge, 1936.
Sumner, F. B. Studies of Protective Color Change. III. Experiments with Fishes both as Predators and Prey. Proc. Nat. Acad. Sci., XXI, 345—353, Washington, D. C., 1935.

Sumner, F. B. Does "Protection Coloration" Protect? Results of some experiments with Fishes and Birds. Proc. Nat. Acad. Sci., XX, 559—64, Washington, D. C., 1935.

Sumner, F. B. and Fox, D. L. Studies of carotenoid pigments in fishes. II. Investigations of the effects of colored backgrounds and of ingested carotenoids on the xanthophyll content of *Girella nigricans*. Journ. Exper. Zool., LXXI, 101—23, Philadelphia, 1935.

Sumner, F. B. and Fox, D. L. Studies of Carotenoid pigments in Fishes. III. The effects of ingested carotenoids upon the xanthophyll content of *Fundulus parvipinnis*. Proc. Nat. Acad. Sci., XXI, 330—340, Washington, D. C., 1935.

Vladykov, V. D. Environment and Taxonomic Characters of Fishes. Trans. Roy. Canad. Inst., XX, 100—40, Toronto, 1934.

Wald, G. The Visual Purple System in Marine Fishes. Nature, CXXXVI, 913, London, 1935.

Wells, N. A. Variations in the Respiratory Metabolism of the Pacific Killfish *Fundulus parvipinnis* due to Size, Season, and Continued Constant Temperature. Physiol. Zool., VIII, 318—36, Chicago, 1935.

EGGS AND LARVAE

de Gaetani, D. Uova, sviluppo embrionale e stadi post-embrionali negli *Sparidi*. 3. *Pagellus acarne C. V.* R. Com. Talassogr. Ital., Mem. CCXX, Venezia. 1935.

Lindauer, V. W. Presence of Roes in New Zealand Marlin Swordfishes. Nature, CXXXVI, 797—98, London, 1935.

Mielck, W. und Künne, C. Fischbrut- und Plankton-Untersuchungen auf dem Reichsforschungsdampfer "Poseidon" in der Ostsee, Mai—Juni 1931. Wiss. Meeresunters. N. F., Abt. Helgoland, XIX, Abhandl. Nr. 7, Kiel und Leipzig, 1935.

Spartà, A. Contributo alla conoscenza dello sviluppo nei Percidi. Uove ovariche mature di *Epinephelus guaza* L. et stadi postembrionali e larvali di *Epinephelus alexandrinus* Cuv. e Val. R. Com. Talassogr. Ital., Mem. CCXXIV, Venezia, 1935.

FISH PARASITES AND DISEASES

Georgévitch, J. Rapport sur les Protozoaires (1er rapport). Comm. Internat. p. l'Explor. Sci. de la Mer Méditerranée. Rapp. et Proc.-Verb., N. S. IX, 137—63, Paris, 1935.

Stekhoven, J. H. S. Copepoda Parasitica from the Belgian Coast. Bull. Mus. Roy. d'Hist. Nat. de Belgique, XI, No. 7, Bruxelles, 1935.

Wilson, C. B. A Parasitic Copepod, *Pupulina flores*, redescribed after forty years. Parasitology, XXVII, 593—97, Cambridge, 1935.

PLAICE AND OTHER PLEURONECTIDS

Blegvad, H. Transplantations of Plaice from the North Sea to the Belt Sea 1928—1933. The Scientific Survey. Rep. Danish Biol. Stat., XXXIX, 9—84, Copenhagen, 1935.

Bowman, A. Spawning Migrations of Plaice and Lemon Soles. VII Cong. Internat. d'Aquicul. et de Pêche, Paris 1931, III, Paris, 1935.

Cieglevicz, W. The Growth of Flounder *(Pleuronectes flesus)* caught in the Bay of Danzig and in the Western Baltic. Arch. d'Hydrobiol. et d'Ichthyol., IX, 108—21, Suwalki, 1935. (In Polish, English Résumé).

Kändler, R. Häufiges Vorkommen von Bastarden zwischen Scholle und Flunder in der Ostsee. Der Fischmarkt, N. F. III, 256—59, Cuxhaven, 1935.

COD

Fridriksson, A. Ársrit Fiskifélags Islands 1935. I. Fiskirannsoknir IV. Reykjavik, 1935.

McKenzie, R. A. Codfish in Captivity. Progress Rep. Atlantic Biol. Stat., St. Andrew's, N. B., No. 16, 7—10, 1935.

Norway. Lofotfisket 1935. Årsber. vedk. Norges Fisk. 1935, Nr. 2, Bergen, 1935.

Rollefsen, G. The Spawning Zone in Cod Otoliths and Prognosis of Stock. Fiskeridirek. Skr., Ser. Havunders., Rep. Norwegian Fish. and Mar. Invest., IV, No. 11, Bergen, 1935.

HADDOCK

Anon. North Sea Haddock Fisheries. Fish Trades Gazette, 21, London, 23-XI-35.
Faruqi, A. J. The Development of the Vertebral Column in the Haddock *(Gadus aeglefinus)*. Proc. Zool. Soc. London, 1935, Part II, 313-32, 1935.
Raitt, D. S. North Sea and its Harvest: Great Importance of the Haddock. Fishing News, 14—15, Aberdeen, 15—II—36.
Vladykov, V. D. A "Three-eyed" Haddock *(Melanogrammus aeglefinus)* Caught at St. Andrews, N. B. Canadian Field-Naturalist, XLIX, 64—7, Ottawa, 1935.

HAKE

Hickling, C. F. Hake Fisheries of Great Britain. Fishing News, 6—7, Aberdeen, 1-II-36.

TUNNY

Hora, S. L. and Mukerji, D. D. European Species of Fish from the Tavoy Coast, Burma. Nature, CXXXVII, 152, London, 1936.

HERRING

Anon. Herring Invasion at Firth of Tay. Fishing News, 8, Aberdeen, 8-II-36.
Ford, E. The Advance of Herring Research. Nature, CXXXVI, 896—97, London, 1935.
Fridriksson, A. Ársrit Fiskifélags Islands 1935. I. Fiskirannsoknir IV, Reykjavik, 1935.
Graham, M. Letter to the Editor. Journ. du Conseil, X, 318, Copenhague, 1935.
Steffen, W. Die grosse Heringsfischerei im Jahre 1934. Jahresber. Deutsch. Fisch. 1934, 224—28, Berlin, 1935.
Tester, A. L. The Herring-Fishery of British Columbia, Past and Present. Prov. of Brit. Columbia, Rep. Comm. Fish. for the Year ended December 31st, 1934, 76—103, Victoria, B. C., 1935.
Wood, H. North Sea and its Herring Harvest. Fishing News, 24—25, Aberdeen, 8-II-36.

PILCHARD, SPRAT AND ANCHOVY

De Buen, F. Rapport sur les Clupéidés et leur Pêche (6e rapport). Comm. Internat. p. l'Explor. Sci. de la Mer Méditerranée. Rapp. et Proc.-Verb., N. S. IX, 95—129, Paris, 1935.
Le Gall, J. Un aspect du problème sardinier. Pêche Marit., Pêche Fluviale et Piscicult., XVIII, 395—96, Paris, 1935.

EELS

Bertin, L. Migrations et métamorphoses de l'Anguille d'Europe. Paris, 1935.

FRESHWATER FISH

Alexander, G. J. A Brief Statistical Review of the Sockeye Fishing and Canning Industry in Rivers Inlet. Prov. Brit. Columbia, Rep. Comm. Fish. for the Year ended December 31st, 1934, 68—75, Victoria, B. C., 1935.
Bahr, K. Was fressen unsere Ostseelachse? Die Deutsche Fischwirtschaft, II, Heft 52, 954, Berlin, 1935.
Clemens, W. A. The Pacific Salmon in British Columbia Waters. Prov. of Brit. Columbia, Rep. Comm. Fish. for the Year ended December 31st, 1934, 103—05, Victoria, B. C., 1935.
Clemens, W. A. and Clemens, L. S. Contributions to the Life-History of the Sockeye Salmon. Prov. of Brit. Columbia, Rep. Comm. Fish. for the Year ended December 31st, 1934, 20—58, Victoria, B. C., 1935.
Crichton, M. I. Scale-Absorption in Salmon and Sea-Trout. Fisheries, Scotland, Salmon Fish., IV, Edinburgh, 1935.
Foerster, R. E. and Pritchard, A. L. The Identification of the Young of the Five Species of Pacific Salmon, with notes on the Fresh-Water Phase of their Life-History. Prov. of Brit. Columbia, Rep. Comm. Fish. for the Year ended December 31st, 1934, 106—16, Victoria, B. C., 1935.

Gorsky, N. W. Der Lachs (*Salmo salar brevipes* Smitt) des Wyg-Flusses, sein Fang und Biologie. Rep. Karelia Sci. Res. Fish, Stat., I, 173—225, Leningrad, 1935. (In Russian, German Résumé).
Ireland. Statistics of Salmon, Sea Trout and Eels Captured during the Years 1927, 1929, 1931 and 1933. Dept. of Agric., Fish. Branch, Dublin, 1935.
Merriman, D. The Effect of Temperature on the Development of the Eggs and Larvae of the Cut-throat Trout (*Salmo clarkii clarkii* Richardson). Journ. Exper. Biol., XII, 297—305, London, 1935.
Motherwell, J. A. Reports from Salmon-Spawning Areas and Egg-Collections. Prov. of Brit. Columbia, Rep. Comm. Fish. for the Year ended December 31st, 1934, 59—67, Victoria, B. C., 1935.
Nall, G. H. Sea-Trout of the Montrose District. Part II. Growth on the Scales of Recaptured Fish. Fisheries, Scotland, Salmon Fish., II, Edinburgh, 1935.
Nall, G. H. Sea-Trout of the Montrose District. Part III. The Migrations of Sea-Trout. Fisheries, Scotland, Salmon Fish., III, Edinburgh, 1935.
Poulsen, E. M. Recent Investigations into the Stock of Salmon and Sea-Trout in the River Gudenaa. Rep. Danish Biol. Stat., XL, 9—38, Copenhagen, 1935.
Sborowskaja, M. B. Zur Kenntnis des Fanges und der Biologie des Onega-Lachses (*Salmo salar relictus* Malmgren). Rep. Karelia Sci. Res. Fish. Stat., I, 257—80, Leningrad, 1935. (In Russian, German Résumé).
Schaposchnikowa, G. Ch. Biologie des jungen Lachses (*Salmo salar brevipes* Smitt) und des Tinda (Jakobslachses) im Wyg-Flusse. Rep. Karelia Sci. Res. Fish. Stat., I, 227—40, Leningrad, 1935. (In Russian, German Résumé).
Schindler, O. Die Brut der mitteleuropäischen Süsswasserfische. III. Der Huchen *Salmo hucho* L. Allgemeine Fischerei-Zeitung, LX, 306—14, Augsburg, 1935.
Wirolainen, M. P. Lachszuchtversuche im Wyg-Flusse. Rep. Karelia Sci. Res. Fish. Stat., I, 241—56, Leningrad, 1935. (In Russian, German Résumé).

Oysters and other Lamellibranchs.

Clark, A. E. The Effects of Temperature and Salinity on the Early Development of the Oyster. Progress Rep. Atlantic Biol. Stat., St. Andrews, N. B., No. 16, 10, 1935.
Erdmann, W. Untersuchungen über die Lebensgeschichte der Auster, Nr. 5. Über die Entwicklung und die Anatomie der "ansatzreifen" Larve von *Ostrea edulis* mit Bemerkungen über die Lebensgeschichte der Auster. Wiss. Meeresunters. N. F., Abt. Helgoland, XIX, Abhandl. No. 7, Kiel und Leipzig, 1935.
Galtsoff, P. S., Prytherch, H. F., Smith, R. O. and Koehring, V. Effects of Crude Oil Pollution on Oysters in Louisiana Waters. Bull. Bureau Fish., XLVIII, 144—210, Washington, D. C., 1935.
Kändler, R. Austernwirtschaft im Ausland und in Deutschland. Der Fischmarkt, N. F. III, 312—23, Cuxhaven, 1935.
Kändler, R. Austernwirtschaft im Ausland und in Deutschland. Der Fischmarkt, N. F., IV, 4—9, Cuxhaven, 1936.
Miyazaki, I. On the Development of Some Marine Bivalves, with Special Reference to the Shelled Larvae. Journ. Imp. Fish. Inst., XXXI, 1—10, Tokyo, 1935.
Newcombe, C. L. Validity of Concentric Rings of *Mya arenaria*, L. for Determining Age. Nature, CXXXVII, 191—92, London, 1936.
Newcombe, C. L. A Study of the Community Relationship of the Sea Mussel *Mytilus edulis* L. Ecology, XVI, 234—43, Brooklyn, 1935.
Spärck, R. Investigations on the Biology of the Oyster XI. On the size and age-composition of the stock oyster in 1935. Rep. Danish Biol. Stat., XL, 39—41, Copenhagen, 1935.
Takatsuki, S. Beiträge zur Physiologie des Austerherzens. V. Über den Bau des Herzens unter besonderer Berücksichtung seiner physiologischen Reaktionen. Sci. Rep. Tokyo Bunrika Daigaku, Section B, II, 55—62, Tokyo, 1934.
Teissonnière, M. Rapport sur l'Hygiène et la Salubrité des Coquillages (2e rapport). Comm. Internat. p. l'Explor. Sci. de la Mer Méditerranée. Rapp. et Proc.-Verb., N. S. IX, 145—63, Paris, 1935.

CRUSTACEA

André, M. et Lamy, E. Les Ecrévisses de France. Paris, 1935.
Panning, A. Wollhandkrabben wurden markiert. Der Fischmarkt, N. F. IV, 20—21. Cuxhaven, 1936.

Whales and Seals.

Jacobsen, A. P. Endocrine Organs of the Blue Whale. Nature, CXXXVI, 1029, London, 1935.
Stephen, A. C. Lesser Rorqual in Aberdeenshire; Risso's Dolphin stranded in Banffshire. Scottish Naturalist, No. 216, 175, Edinburgh, 1935.

Aquarium Equipment.

Böhnke, K. Das Meeres-Aquarium: seine Einrichtung und Pflege. Berlin, 1935.
Lloyd, Ll. Prevention of Clogging of Strainers in rearing Aquatic Organisms. Nature, CXXXVI, 646—47, London, 1935.
Watson, M. The Amateur Aquarium Keeper. London, 1935.

Biological-Miscellaneous.

Buchanan-Wollaston, H. J. The Philosophical Basis of Statistical Analysis. Journ. du Conseil, X, 249—63, Copenhagen, 1935.
Stiasny, G. Das Bipolaritätsproblem. Arch. Néerland. Zool., I, 35—53, Haarlem, 1934.

Notice to Contributors.

1) All contributions should be type-written, on one side of the paper only.
2) Drawings and diagrams for reproduction should be prepared in waterproof Indian Ink (Encre de Chine) on Bristol Board or other perfectly smooth, white paper or card. No erasures should be made. Shading should be limited to the minimum necessary, and when used the shading lines should be kept open. Fine and dotted lines should be drawn boldly.

   Lettering should be inserted only in pencil: the block-maker will be responsible for the definitive lettering.

   Drawings should if possible be twice the diameter required, and when reduced should occupy a maximum space of 18 cms. in length and 11 cms. in width, including the space for the legend. The shape should be such as to fit easily into the page.

   The size to which drawings are to be reduced should be noted in pencil on the originals.

   When several illustrations are required for the same article they may be drawn on the same sheet, allowing at least 5 cms. between them.

   Charts and curves may be drawn to advantage on graph-paper ruled in pale blue lines, as these lines do not appear in photographic reproduction.

   Legends for figures should be type-written on a separate sheet.
3) For satisfactory reproduction of photographs a good glossy bromide print is required, and all added matter, such as reference letters, arrows, numbers etc., should be drawn on the face of the photograph or indicated on tracing paper attached to the back of the print and folded over the front. If matter is written on the face of the photograph a duplicate print without the added matter should be supplied.

   Legends should be written on the back of the photographs, or type-written on a separate sheet.

Recent Publications of the International Council:

RAPPORTS ET PROCÈS-VERBAUX.

Vol. XCIII: *Rapport Atlantique 1933.* February 1935. Kr. 1.50.

Vol. XCIV: *Part I: Procès-Verbaux (Mai — 1935).* August 1935. Kr. 3.00.
Part II: Rapport Administratif (1934—1935). July 1935. Kr. 3.50.
Part III: Appendices (1934—1935). August 1935. Kr. 3.50.

Vol. XCV: *Reports of the Proceedings of the Special Plankton Meeting held on May 27th, 1935, at Copenhagen and of the Special Meeting held at Videnskabernes Selskab's Premises on May 31st, 1935.* (In preparation).

Vol. XCVI: *Laws and Regulations concerning Salmon and Trout Fisheries.* (In preparation).

Vol. XCVII: *Guide for Reading Scales of Salmonoid Fishes.* (In preparation).

BULLETIN HYDROGRAPHIQUE *pour l'année 1934.* December 1935. Kr. 7.00.

BULLETIN STATISTIQUE *pour l'année 1933.* December 1935. Kr. 3.00.

Attention is drawn to the Series E:—

FAUNE ICHTHYOLOGIQUE DE L'ATLANTIQUE NORD, of which Nos 1—15 have been issued. Each Kr. 4.00.

Table of Contents.

Page

1. Obituary Notice:—
   Rowland Southern (1882—1935) by **A. C. Gardiner**. 3
2. **H. J. Buchanan-Wollaston.** The Philosophic Basis of Statistical Analysis (Continued) 7
3. **Adolf Kotthaus.** Die Schollenbevölkerung der Deutschen Bucht im Jahre 1935 27
4. **D. E. Thursby-Pelham.** The Decline in the Lowestoft Plaice Fisheries 33
5. **G. P. Farran.** On the Mesh of Herring Drift-Nets in relation to the Condition Factor of the Fish 43
6. **C. E. Lucas.** On the Diurnal Variation of Size-Groups of Trawl-Caught Herring... 53
7. **J. Armitage Robertson.** A Preliminary Account of the Sprat and Sprat Fishery in England.. 60
8. **C. V. Otterstrøm.** Die Turbinen und die abwärts wandernden jungen Lachse und Forellen (sowie Aale). 3. Teil 72
9. **H. C. Godsil.** Tuna Tagging... 94
10. Reviews 98
11. Current Bibliography prepared by the Editor with the assistance of Miss **Thursby-Pelham** 117

A/S L. IHRICH – COPENHAGEN